THE FOUNDRY

A Monthly Journal for all Departments of the Foundry Business

Vol. 40, No. 9 Cleveland, Ohio, September 1912 Whole No. 241

Making Steel Castings by the Crucible Process

Discussion of the Molding and Melting Practice of a Large Milwaukee Foundry, With a Few Hints on Gating

IN THE statistics of the American foundry industry published in the August issue of THE FOUNDRY, attention was directed to the remarkable growth of the steel casting industry during the past two years, but in this connection it was pointed out that the crucible process is almost stationary in output. From this it should not be inferred that the crucible steel casting industry is decadent, the facts being quite to the contrary. During the past few years this branch of the foundry trade has made rapid progress, not so much in the direction of increased tonnage as in greater diversity of output, covering a much wider range of work than was previously considered possible. The growth of the automobile industry and the great advances made recently in the design and capacity of agricultural machinery have created a special demand for quantities of small, intricate castings varying from a few ounces up to 80 pounds or more in weight.

To supply this demand the production of light, crucible steel castings is showing a steady increase and work is being turned out today in crucible steel that a few years ago would have taxed the ingenuity of our best malleable foundrymen. Thousands of castings weighing less than a pound apiece are now being made successfully in steel and many more weigh less than three ounces each. To the older generation of crucible steel men, such results would have been considered preposterous. Progress of this character is not reflected in

FIG. 1—IMPROVED CRUCIBLE STEEL MELTING FURNACES OF THE OIL-BURNING, MILWAUKEE TYPE

FIG. 2—TEEMING INTO MOLDS WITH UPRIGHT MOLDS IN THE FOREGROUND

tonnage statistics. Although the tonnage has changed only slightly in the past two years, the number of castings made has increased perceptibly; the average weight per casting is less and the value of the product has increased. The next biennial period will undoubtedly show further progress along the same line.

Sivyer Steel Casting Co.

Among the organizations which have been influential in bringing about this change in the character of the crucible steel casting industry, the Sivyer Steel Casting Co., of Milwaukee, is typical. Milwaukee is the center of this branch of the foundry trade, there being over a dozen crucible foundries in the city with an aggregate annual production of about 10,000 tons. It is only natural, therefore, that the progressive shops should be located in this vicinity.

The Sivyer Steel Casting Co. was organized late in 1908 and commenced operations Feb. 23, 1909, with only 11 men in a small shop adjacent to the plant of the Chain Belt Co. and Northwestern Malleable Iron Co. As it was rather difficult at that time to obtain business of the character generally considered desirable for a crucible steel foundry, the management of the new concern poached on preserves that were considered sacred to the malleable industry. With almost no experience as a guide, many practical obstacles were encountered in the shop and had to be surmounted and much pioneering was necessary. This is reflected in the early cost sheets of the organization. Gradually, however, the principles in this new field were mastered and the business grew and prospered. Today over 75 men are employed and the output reaches 125 tons of finished castings per month. The plant of the Sivyer company, therefore, ranks among the largest in its field in the country.

The character of the work turned out is illustrated in Figs. 4 to 6, inclusive, and in Fig. 10. Recent records show that the average weight per casting is approximately 6.5 pounds, but the shop is equipped to turn out castings varying from 2½ ounces to 500 pounds each. In fact, in one or two instances, orders have been executed for castings weighing considerably less than two ounces apiece, although such jobs must be considered exceptional. But, as previously suggested, this shop specializes on light work similar in its general character to the output of the average malleable foundry. The product includes low and high carbon cast steel, plain or annealed, suitable for welding and tempering, also vanadium, titanium and other alloy steels.

Arrangement of the Shop

The plant is located in one of Milwaukee's newest manufacturing districts on the west side near National avenue and Thirty-eighth street. Ample ground has been acquired for future expansion. The altitude is high, drainage good and living conditions are superior to those found in the ordinary manufacturing suburb. The main building which houses the molding, melting, cleaning, annealing and shipping departments is 150 feet in length and 70 feet in width. It is a frame structure of the slow burning type divided by two longitudinal roof trusses and rows of columns into three bays. The south and center bays are devoted to molding; the melting and annealing departments occupy the north bay which is about 20 feet wide. The molding floor is about 130 feet long and 55 feet wide. The floor area is, therefore, 7,150 square feet; the capacity of the shop is 125 tons monthly or five tons daily; hence 1,430 square feet of molding floor are required per ton of finished castings produced daily. The molding machines are arranged under the windows along the south wall; the machines occupy

FIG. 3—EAST END OF MOLDING FLOORS, SHOWING FLASKS TILTED AND PLACED ON END FOR POURING

only a portion of the wall space, the balance being utilized for bench molding. At the west end of the building space has been set aside for the cleaning and shipping departments. The core department is located in a small building connecting with the south side of the main foundry. The pattern and flaskmaker's shop, pattern storage and office are in a separate structure just north of the main building. The raw stock is stored in suitable bins and sheds located along the railroad track east of the shop; the fuel oil is stored in two large horizontal steel tanks having a capacity of four carloads from which it feeds by gravity into the furnaces. The plant is provided with a spur track for receiving and shipping material by rail.

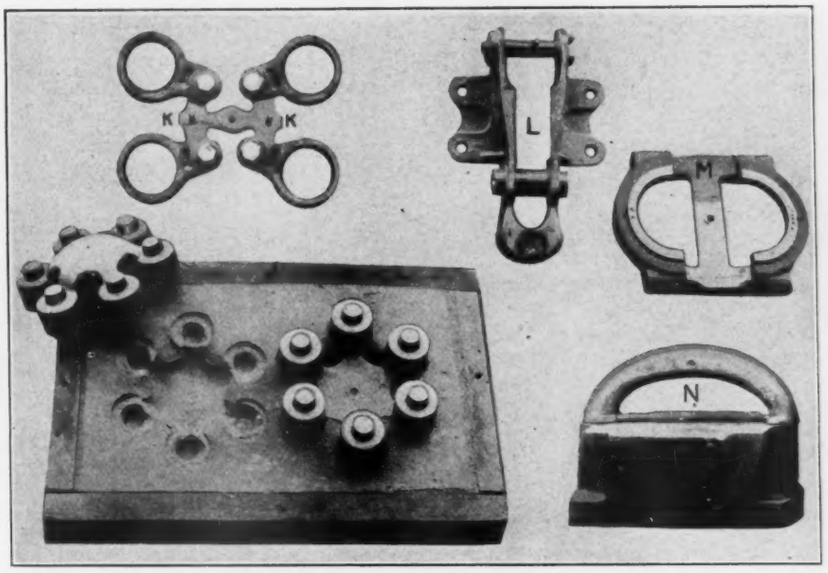


FIG. 5—ROLLER PATTERNS GATED AND MOUNTED ON A FOLLOW-BOARD. MISCELLANEOUS PATTERNS PROPERLY GATED FOR CRUCIBLE STEEL ALSO ARE SHOWN

Melting Furnaces

The melting department includes ten 6-pot oil-burning furnaces, Fig. 1, of the improved Milwaukee type. They are approximately 9 feet long, 5 feet wide and 6 feet deep over all and project 12 inches above the floor line. The melting chamber is 4½ feet long, 3 feet wide and 30 inches deep. There is a cleaning pit, 2½ feet wide at the front and sides of each furnace. The original Milwaukee furnace was described in THE FOUNDRY, December, 1909, page 143. It had a melting capacity of 1,400 pounds per day and consisted of three chambers holding a total of four pots. The first chamber was used for melting, the second, although intended for melting, was found available only for pre-heating and the third compartment was never used except for examining the flame. Although this furnace was arranged to hold six pots there were never more than two exposed to melting heat at the same time. The average daily run was seven heats of two pots each, consuming 170 gallons of oil. The oil consumption per ton of steel melted was approximately 282 gallons. The furnace had a life of about 16 days, when the side walls and arches had to be rebuilt. The old furnace, however, was easy on crucibles, from five to six heats per pot being obtainable occasionally. Of course the charges after the third heat were greatly reduced, and the economy in crucibles was more apparent than real. Experiments showed that the cost of melting after the third heat, especially if the pot was worn away considerably, was often greater than the cost of new crucibles. This is due largely to the fact that the oil consumption for a short heat is practically as great as for a full heat, and the daily output per furnace is greatly reduced. In addition, there is always the danger of the old pot breaking in the furnace when the resultant expenditure for repairs is always greater than any possible saving that can be effected by the use of burned crucibles.

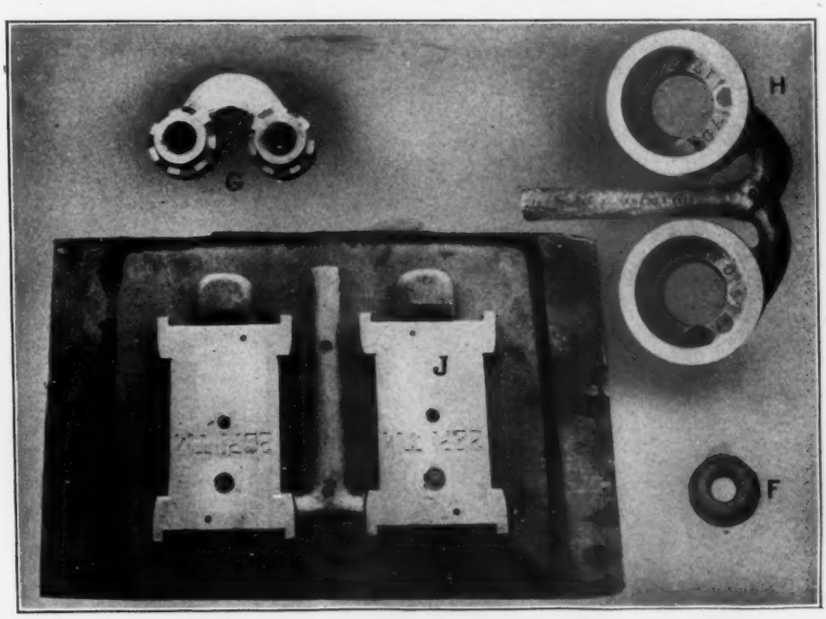


FIG. 4—PATTERNS WHICH ILLUSTRATE THE METHODS OF GATING

Improved Milwaukee Furnace

The improved furnaces installed in the Sivyer foundry are the result of recent experience and represent a considerable advance over the original Milwaukee type. Instead of two bridge walls and three melting chambers, there is but a single compartment holding six pots, all of which are subjected to a melting heat. A longitudinal view and a cross-section of the improved furnace are shown in Fig. 12; cold air enters through the spaces between the pans and through the air slot, *D*, following the dotted line to the stack. The burners are of the improved Mitas type and are illustrated in Figs. 1 and 12. From the supply pipes, *L*, shown in front of each furnace in Fig. 1, the oil drops into a series of four pans equipped with overflows, which convey the oil from each pan to the one next beneath. Cold air for combustion enters at *C*, Fig. 12, and through the air slot at *D*. The damper, *F*, regulates the draft, while the

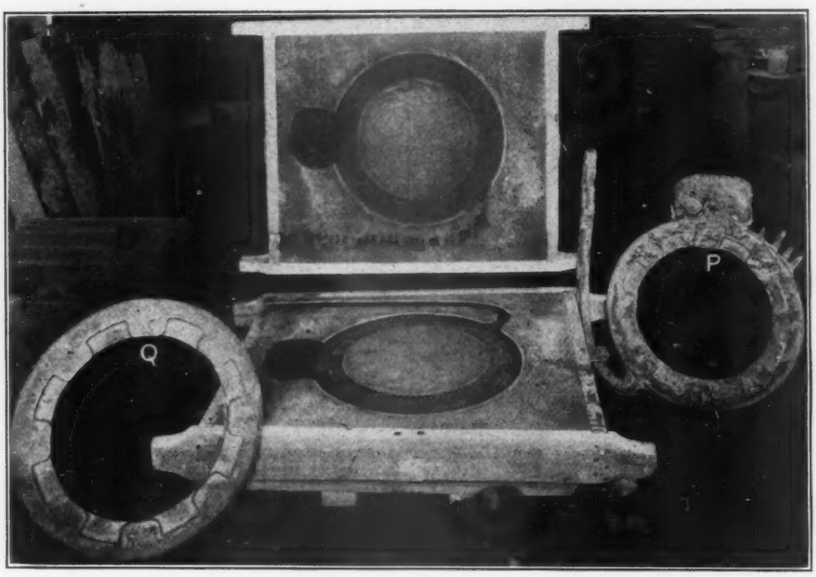


FIG. 6—A HEAVY SPROCKET WHEEL CAST IN CRUCIBLE STEEL

iron plates shown in Fig. 1 regulate the air supply. When pulling the pots the main damper is closed and the by-pass, *G*, Fig. 12, is opened, allowing the flames to pass up the stack without entering the melting chamber. In the older type of furnace but three oil-drip pans were used in the burner. A layer of crushed coke and old crucibles is placed at the bottom of the furnace. No. 60 crucibles holding 150 pounds of metal when new are used.

Natural Draft

There is, of course, no forced draft, the furnaces being connected to a steel stack, 100 feet high and 48 inches inside diameter. In addition to the regular main flue connecting the stack with the furnaces there is an auxiliary flue or by-pass which may be used. The auxiliary flue enters between the third and fourth furnaces, counting from the east end of the row, and the main flue between the seventh and eighth, thus dividing the battery into two groups of three and one group of four furnaces. Suitable dampers are provided so either flue may be connected to either one or both of the adjacent groups of furnaces. As a result of this arrangement it is not necessary to shut down the plant for flue repairs as is the case where there is only one flue between the stack and furnaces.

These furnaces have a life of about two weeks when the side walls and arches must be rebuilt, temporary repairs being made at intermediate intervals. A second quality refractory brick is used, as the irregularity of furnace operation, only about 14 hours per day, causes the brick to spall or chip off. If the furnaces could be run continuously, a higher grade brick could be used in the lining, which would increase the life and consequently lessen the cost of production. The oil consumption is approximately 224 gallons per ton of steel melted as compared with 282 with the older style furnaces. Each furnace has a daily capacity of 2,800 pounds of metal, or double that of the older type. The total melting capacity of the 10 furnaces in the plant is, therefore, 14 tons daily.

In operation, the furnaces are lighted early in the morning in order to get out the first heat at 7 a. m. About two hours are required to melt down a heat and the average life of a crucible is from three to four heats. The crucibles are stored along the wall behind the furnaces as shown in Fig. 1, where they are annealed and seasoned before being used. The crucible charges, with the exception of about 10 per cent returned sprues, consist of mild steel boiler punchings which pack well in the pots. Care is taken that the punchings run less than 0.04 per cent in phosphorus and sulphur and they generally contain from 0.25 to 0.35 per cent manganese and from 0.12 to 0.18 per cent carbon. The slight amount of silicon in the stock is practically all absorbed in the slag when the metal is melted. To increase the soundness of the castings, 80 per cent ferro-manganese and 50 per cent ferro-silicon is added in varying quantities not exceeding 1 per cent. The castings, it is claimed, have a tensile strength of from 60,000 to 65,000 pounds per square inch unannealed and about 5,000 pounds more when annealed. High carbon steel of greater strength may also be produced. The product also possesses the uniformity which characterizes crucible steel.

Lifting the Pots

The tongs used for lifting the pots are illustrated in Fig. 1. They are carefully fitted to the crucible so that the distance between the handles where the chain is attached is not too great, otherwise there will be too much strain on the pot. Blocks and chain tackle, as shown in Fig. 1, are used to pull the crucible from the furnace. The tongs are fitted and the operation superintended by the melter, the tackle being handled

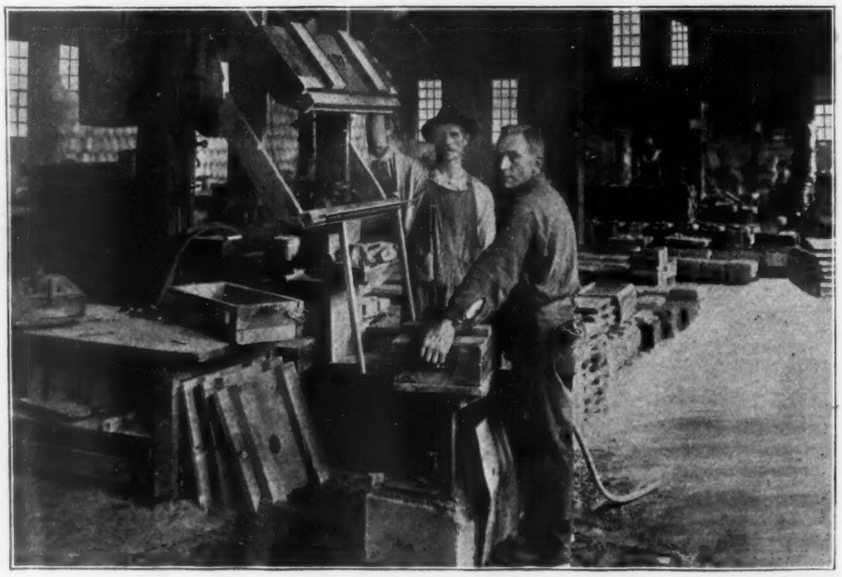


FIG. 7—JARRING MACHINE USED FOR MOLDING CONNECTING RODS. THE MOLDER IS DRAWING THE PATTERN

by the helper. For removing furnace covers the levers, *K*, Fig. 1, suspended by chains from overhead trolleys, are used. The furnace covers are extra heavy, which gives them a long life and are similar in construction to the bungs over an air furnace. For teeming the metal into the molds the shank shown in Fig. 2 is used. One end has the usual handle and the other is made in the form of tongs which grip the crucible securely; the shank is made sufficiently heavy so that it will not lose its shape or become warped by the heat. This form of shank is preferred to the ordinary solid ladle shank because an extra man with a hooked rod is required in the latter case to prevent the crucible from falling out. When the crucibles are removed from the fire, the metal is skimmed and then is poured into the molds, being skimmed a second time during this operation.

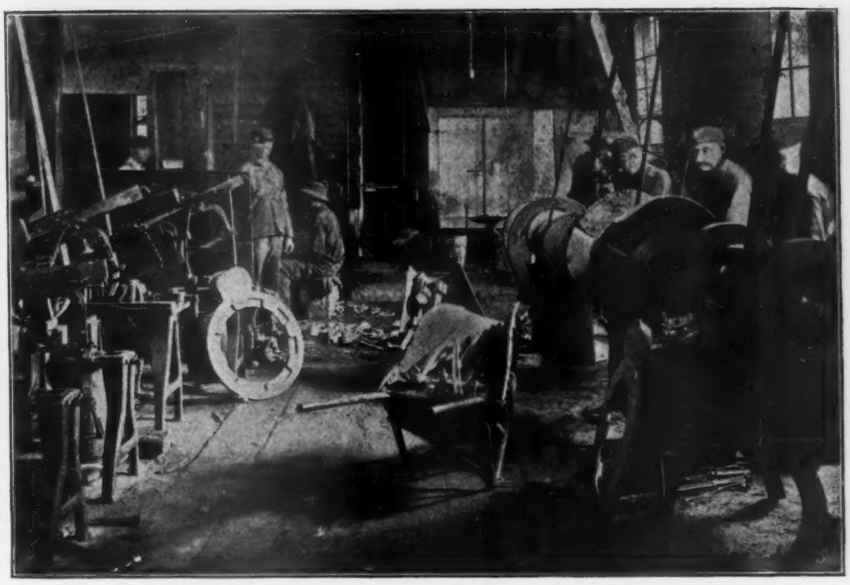


FIG. 9—A VIEW OF THE CLEANING DEPARTMENT

Molding Practice

Molding practice differs in several particulars from that followed in gray iron and malleable foundries, on account of the peculiar nature of crucible steel. The period of fluidity is much shorter than in the case of iron and it is necessary, therefore, to provide exceptionally free-vented molds, unusually large shrink heads and other devices to avoid blow-holes and insure sound castings. Better results are obtained when the casting is under a considerable pressure or head and when the metal rises in the mold from the bottom instead of being poured in from the top. Consequently, many molds are cast with the flasks set on end or tilted as shown in Figs. 2 and 3. Also, where possible, especially with small castings, the gates are attached at the bottom so that the metal rises in the mold and is at the same time subjected to pressure due to the hydrostatic head of the fluid metal in the runner. Heavy molds are made on the floor in the usual manner, but most of the work is done on the bench or on squeezer or jarring machines. These features will be discussed more in detail later.

The large flasks shown in the foreground in Fig. 3, tilted with the runners at the upper end, each contain a pair of automobile starting levers. The levers are about 30 inches long with comparatively thin sections and unless the flasks were tilted in the manner shown the molten metal would never fill the molds.

Although large numbers of wooden flasks are employed, particularly for special jobs, as fast as possible the work is being standardized and Sterling metal flasks, similar to those in the foreground in Fig. 2, are being substituted. The life of the metal flasks is much greater than that of wooden ones, especially where the molds are poured on edge through the parting. The employment of upright molding instead of flat work reduces the daily production from 15 to 20 per cent, but is preferable on account of the better results obtained. In pouring the upright molds, the metal is teemed from the ladle very slowly in order to allow sufficient time for the shrinkage action and an opportunity for the gases to escape gradually.

Contrary to general custom, a special gang of men is employed to pour the molds and the molder does not handle any hot metal. This system has two advantages; the daily production of the molders is increased at least 20 per cent and casting losses are reduced. An average of about 100 pounds of metal per man-hour is obtained in this way.

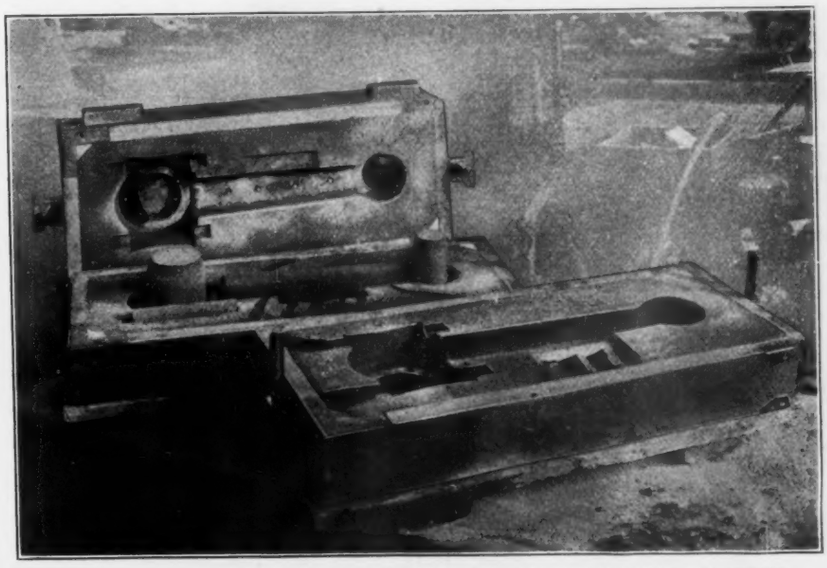


FIG. 8—CONNECTING ROD MOLD RAMMED ON A JARRING MACHINE

Arranging Patterns for Crucible Steel

As previously stated, a considerable portion of the output of the Sivyer Steel Casting Co. is similar to the product of a first-class malleable foundry and many of the patterns received were originally made for malleable work. Before they can be cast in crucible steel it is necessary to re-gate patterns of this type. New patterns are frequently cast in non-shrinking white metal for this purpose. Also, when plain wood patterns are furnished by the customer it is often economical to duplicate them in white met-

FIG. 10—SHIPPING DEPARTMENT, SHOWING A LARGE VARIETY OF CRUCIBLE STEEL CASTINGS

al, with suitable gates. For crucible steel work, heavy, thick gates and risers containing a large volume of metal are necessary and the gate must be full size or even slightly enlarged where it enters the mold. On small work the weight of gates and sprues will often equal and at times exceed the weight of the castings. Averaging all of the work produced in the Sivyer foundry, the heads and gates contain 28.5 per cent of the metal poured.

Figs. 4 and 5 show how the patterns are gated, provided with follow-boards and prepared for molding. At *F*, Fig. 4, is shown the original wood pattern of a small claw clutch used in an automobile. The teeth are cut to size and for pieces of this sort crucible steel is almost a necessity. A pair of white metal gated patterns ready for molding, made from the wood pattern, *F*, are shown at *G*. Each casting weighs less than a pound and the gate weighs approximately as much as the two castings to which it is attached. The gate is made extra large in this case in order to have perfectly sound, full size castings.

Method of Gating

The illustration, *H*, Fig. 4, shows how two small wheels are gated and poured in an upright position in the flask. The wheels are about 5 inches in diameter. The pattern board, *J*, shows two parts for a tractor engine arranged for vertical pouring with the gates at the bottom. It will be noted that large shrink heads are connected to the top of each casting in order to prevent shrink holes appearing after the castings are machined.

The follow-board in Fig. 5 contains two gated metal patterns, each carrying six small rollers and the illustration shows very clearly how these patterns are mounted with a very heavy, solid, star-shaped gate. Above the follow-board at *K*, Fig. 5, is a gated pattern for molding four duplicate parts of a jack; the metal in this case enters through a central runner and is conveyed to the castings through a pair of double gates of large size. At *L* in the same illustration is a pattern for a crucible steel chain link, the gate in this case being at the bottom or small end. At *M*, Fig. 5, is a cap or collar used on an auto-truck and at *N* is a half pattern of a bearing; the gates used in these cases are taken from a stock of standard shapes and sizes which are kept on hand.

A typical example of heavy floor molding for crucible steel is illustrated in Fig. 6. The rough casting as it comes from the sand with gate and shrink head attached is shown at *P* and the finished part, chipped and cleaned, is illustrated at *Q*. The finished casting, which is a sprocket wheel for a five-ton auto-truck, weighs 83 pounds, while in the rough it weighs 151 pounds. The gate and shrink head, therefore, weigh 68 pounds or 45 per cent of the total. The sprocket is 27 inches in diameter with a rim 4 inches wide and 1 inch thick. It is made of steel containing 0.40 to 0.50 per cent carbon to insure good wearing qualities. The job is molded in a 40 x 48-inch wood flask which is turned on end for casting, as indicated in the illustration. Using an air rammer, a molder and helper put up 10 molds a day. A coarse, free-venting facing sand is used. For handling larger jobs than this, the shop is equipped with a 2-ton I-beam trolley provided with a triplex hoist.

Molding a Gas Engine Connecting Rod

Figs. 7 and 8 show how the connecting rod for a heavy gas engine is molded on a small Mumford jarring machine. The finished casting weighs 41 pounds and is molded in a snap flask 12 inches wide and 30 inches long. There are 22 nails in the mold and five cores to set. A molder and helper turn out 52 molds per day. The shop is equipped throughout with compressed air and a pneumatic vibrator is used in con-

FIG. 11—A VIEW OF ONE SECTION OF THE CORE ROOM

nection with the jarring machine for this job. Fig. 7 shows the molder applying the vibrator and drawing the pattern. The copes and drags are made alternately and matched interchangeably. Each half of the pattern is mounted on a board, the boards being hung conveniently in racks over the machine, as indicated in Fig. 7. The daily production on this and similar jobs could be increased if mechanical means for filling the flask with sand were provided. Fig. 8 shows the finished molds with cores set in the drag. Although a coarse facing is used, a number of good-sized vents are cut in the drag as shown in Fig. 8. Steel jackets are placed around the molds when they are poured to prevent runouts.

In addition to the jarring machine, the plant is equipped with five Berkshire and Adams squeezer machines provided with vibrators for drawing the pattern. These machines are arranged in a row along the south wall of the building and are used for a variety of work. Although a crucible steel casting foundry does not generally receive orders for immense quantities of duplicate castings which would justify a considerable investment in rigging nevertheless the Sivyer company has found the use of molding machines a great help in cutting down the cost of production.

A general view of the cleaning department is shown in Fig. 9. A battery of power hack saws for cutting off heads and risers, a number of large double emery grinders and other machinery such as is usually found in this department are installed. All machines are motor-driven. A complete sand-blast outfit is installed in a separate room adjacent to the cleaning department.

About 75 per cent of the work produced is annealed before shipping and for this purpose an oil-burning annealing oven has been installed. The oven is simply constructed, provided with two plain pipe burners and was erected at little expense. It is about 10 feet square and 8 feet high over all. The charges are annealed 24 hours. Three hours are required to bring the oven up to heat; it is allowed to remain at maximum temperature for five hours and to cool off for 16 hours. The maximum heat is about 1,900 degrees Fahr., varying of course with the nature of the work.

The shipping department, which occupies the northwest corner of the main building, is illustrated in Fig. 10. It is equipped with platform scales and suitable apparatus for packing and handling castings. This illustration gives a clear idea of the variety of work turned out by the shop.

Making the Cores

The core room, Fig. 11, is located adjacent to the south wall of the main foundry. It is approximately 40 feet long and 15 feet wide and is provided with a large shelf oven that occupies the full width of the room at one end. The oven is 7 feet high and 6 feet deep and is fitted with three sets of shelves. The firebox is at one end, with the offtake flues in the rear. About two wheelbarrow loads of coke are burned per day. The coremaking practice is similar to that found in the average good jobbing foundry.

Gradually during the 3½ years that this foundry has been in operation a simple and effective cost system has been evolved, a brief description of which will be of interest. The lack of a suitable cost system is responsible for the downfall of many otherwise successful organizations, and especially in the jobbing foundry business there is a surprising lack of information along this line. A foundryman without an accurate knowledge of his costs is hampered in more ways than one. He not only loses money on jobs unnecessarily but he loses the respect of his customers as well. Customers like to deal with men who know where they stand and can, therefore, be depended upon when the day for delivery arrives.

For purposes of cost keeping, the Sivyer foundry is divided into five departments, namely—melting, molding, cleaning, core and office. Separate detailed accounts showing the expenses, all the expenses, chargeable to each department daily are kept. The daily accounts are summarized monthly, when cost sheets showing the distribution of expense to each department are made up.

In these monthly summaries the office expense, which is in reality a part of the overhead, is distributed among the other four departments in proportion to the payroll in each department. That is, if the molding department has half the total shop payroll, then half the office expense is charged to this department. The

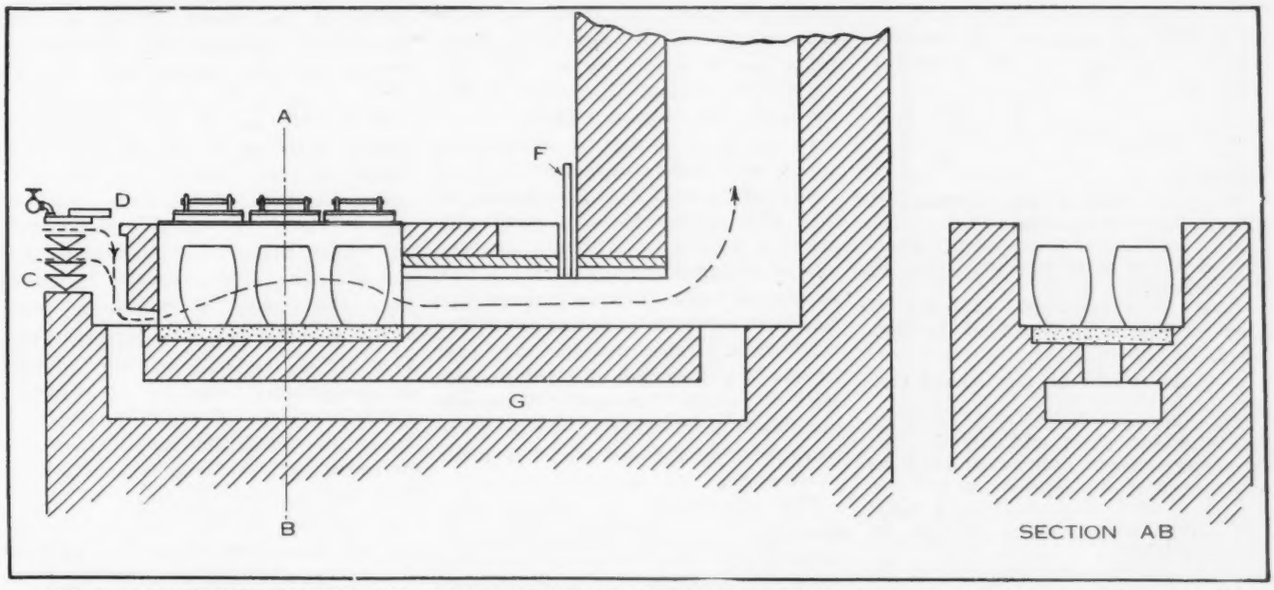


FIG. 12—LONGITUDINAL VIEW AND CROSS-SECTION OF IMPROVED MILWAUKEE TYPE CRUCIBLE STEEL MELTING FURNACE

wages of the office clerks and salaries of the officers of the company are charged to office expense. In this manner the office expense is distributed fairly among the producing departments. The other items of overhead expense, such as power, light, etc., are charged directly to the proper department.

A record of the investment in each department is kept and the various fixed charges are proportioned among the departments in accordance with their respective investments. A distinction is made between fixed charges, like interest and taxes, and overhead expense, such as power and heat. In this manner a complete monthly record of the expense in each department is obtained.

Estimating Cost of Castings

The cost of castings is estimated on a basis of material and molding labor according to the following formula:

$$\text{Cost per pound} = \frac{WP + L + FL}{w}$$

where

W is the total weight of metal required for the casting.

P is the price of the metal per pound.

L is the cost of molding labor for the casting.

F is a factor which expresses all other expenses in terms of molding labor.

w is the weight of the finished casting.

The factor F is obtained from the monthly cost sheet and includes the following items, each expressed as a per cent of molding labor:

$F = N + M + I + C + O$ where

N is the non-productive molding department labor.

M is miscellaneous expense in the molding department.

I is fixed expense in the molding department.

C is cleaning department expense, which includes coremaking.

O is core department expense.

The office expense is divided among the other four departments in accordance with their payrolls and does not appear in the formulae. The foregoing serves for most ordinary uses, but occasionally a factor involving core expense must be introduced where the casting is specially intricate.

With the factor F determined for any given month, it is a very simple matter to estimate the cost of a casting. Assume, for instance, a gear wheel weighing 70 pounds which can be molded by a man and a helper in one hour or at an expense of about 50 cents for molding labor. Assume also the cost of the metal at 4½ cents per pound and 3 as a value for the factor, F. Then the cost of the casting is found as follows:

$$\frac{WP + L + LF}{w} = \frac{100 \times 4\frac{1}{2} + 50 + 3 \times 60}{70} =$$

9.8 cents per pound.

In this case we assume also that the weight of heads and risers is equal to 30 pounds so that the total weight rough is 100 pounds.

Welfare of Employes

In common with other modern organizations, the Sivyer Steel Casting Co. is devoting considerable attention to the comfort and welfare of its men. The company buys congress shoes for the men at wholesale and sells them at absolute cost. Also, in order to militate against the evil effects of the corner saloon, milk is purchased wholesale at 2 cents per quart less than the retail rate and sold to the men at the same price for their luncheons. One day during the summer the shop is shut down for the annual picnic.

In order to encourage suggestions which will result in reduced cost of operation prizes are distributed to men who present ideas of merit. For instance a prize of $10 was awarded one of the men for suggesting a new design of brick for the furnace flue which resulted in a reduction in the brick cost. The melters are paid by the day plus a bonus for exceeding a certain tonnage. Wherever possible the molding is on a piece work basis and every effort is made to encourage production.

The officers of the Sivyer Steel Casting Co. include Frederick L. Sivyer, of the Northwestern Malleable Iron Co., president; C. R. Messinger, vice president; William C. Frye, treasurer, and Willis Collins, secretary.

Chart of Elements

A chart of elements, published by the Metallic Compositions Co., London, is a unique descriptive map of every metal and non-metal which is known to exist either combined or free in nature, and shows all the most important properties and constants which each possesses. Each metal or non-metal occupies a separate section on the map and these sections are arranged upon a new plan based upon the periodic law of the Russian chemist, Mendeleeff. Thus not only are the known properties of the metals available to the reader, but some idea may also be obtained of the probable nature of the properties not yet known.

First Aid to the Injured

Investigations which have been made of accidents in industrial establishments indicate that many serious injuries would have been classified among minor accidents provided first aid could have been administered by a skilled attendant. On the other hand, many cases of minor accidents assume major proportions when the injured fails to obtain the service of a physician and endeavors to treat the injury himself. Fully appreciating the importance and the necessity of a hospital department where all injuries, regardless of their character, can receive prompt attention, the Erie Malleable Iron Co., Erie, Pa., has installed a surgical room at its plant which is modernly equipped throughout. It is in charge of a graduate physician who remains at the works throughout the day. The employes are required to report to this department all injuries, regardless of their gravity, and if only minor, the injured receives attention at the plant at the hands of this physician. On the other hand, if the injury is of a nature which will compel the injured to remain at home he is visited by the physician and attention is given until the wound is healed.

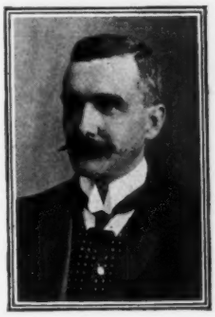
In cases of minor accidents, only first aid is rendered and the injured is immediately sent to a hospital. Exceedingly good results have followed the establishment of this department and the employes receiving this service free of cost call upon the services of the plant physician for all minor injuries which heretofore they have endeavored to care for themselves, frequently with serious results.

A blank containing a history of each accident is carefully filled out by the plant physician. On this is entered the name, age, address, occupation and nationality of the injured, together with his religion and whether he is married or single. A careful record is maintained of when and where the accident happened and the names of witnesses of the accident also are entered on this report. On the reverse side of this blank are front and back views of the human form, with a skeleton in outline, on which is marked the exact location of the injury. In addition, the plant physician describes fully how the accident happened. This record, in the event of a claim for damages, is of great value as it contains all of the necessary data covering the case.

Suggestions for Training Foundry Apprentices*

The Shortage of Skilled Molders All Over the World Indicates a Lack of Interest Among Foundrymen to Perpetuate Their Craft

By J W Horne



IN THE days when trade guilds were in existence, the term apprenticeship signified not only practical training in a particular trade, but also training of character and intelligence, without which it is impossible to become a really efficient craftsman. In those days, during the period of apprenticeship, a youth received such an education as trained him how to live, while at the same time fitting him to become an intelligent workman capable of earning sufficient to provide for the necessities of life. It is not the purpose of this paper to trace the changes which have taken place in the intervening centuries. Anyone who is interested in the subject will find considerable food for reflection in the contents of a book on the subject by Reginald A. Bray. He defines an apprenticeship system worthy of the name as having to satisfy three conditions:

Adequate supervision for boys up to 18 years; supervision must take into account conduct and physical development.

Must offer opportunities of training both general and special; that is, the training of the citizen and the training of the workman.

Provision of a suitable opening on completion of apprenticeship.

Awaken Interest in Training of Apprentices

This system is ideal, and if ever considered is bound to lead to considerable controversy, but no one will deny that every effort should be put forward. No system of industrial education of the apprentice can be effective unless it gives him the capacity for becoming an intelligent workman, a healthy citizen and a good neighbor. The main purpose of this paper is to awaken an interest in the training of foundry apprentices, and to give in concentrated form some account of how the question is being solved in other countries.

The problem of the more efficient education of the engineering mechanic during late years has had the serious consideration of many industrial firms, with the result that considerable progress has been made. But so far as information can be obtained, no great development has taken place in improving the educational standard attained by the foundry apprentice, though the problem has not been neglected by foundry employers. Perhaps the main reason why development in their case is, and has been, so slow, is associated with the fact that as a trade, molding is generally held in low estimation. Though not the most mechanical of the trades, it must be remembered that a mold, to give a sound casting, requires more than the mere force necessary to ram the sand. There are a hundred and one things the molder must know and consider.

Molders to Blame

Molders may have themselves to blame for this condition of affairs; in the first place, because there is only an inconsiderable number of them who have done, or are doing anything to increase the esteem in which the public hold the trade, by increasing their respect for themselves; while in the second place, practically comparatively few molders study the underlying principles involved in the molders' art, or do anything to raise its status in the mechanical world. There can be no question that foundry work requires a considerable display of mechanical ability as well as a sound knowledge of the physical properties and composition of materials used. Whereas, today, in most industries, machinery is taking the place of mechanical skill of the individual, this cannot be said of the foundry, as no great advance has been made in dispensing with hand molding. Great mechanical ability is required to make a man a reliable and good molder. To prove this to the world should be the aim of every molder, commanding thereby increased respect for his trade. One effect of the low estimation in which the trade is held by other tradesmen and engineers in general has always been evident in the poor supply of apprentices with a standard of intelligence equal to that of those entering other trades, especially engineering. While the age of the apprentice entering as a fitter or turner has been raised almost generally to 16, with a resulting advantage, the starting age for the foundry is 14. This means that the boy starts handicapped with a less developed intelligence and at an age when factory life will have a greater deteriorating effect. No doubt much can be done by inducing these foundry boys to attend evening continuation classes; but the good derived from them can only be limited after a strenuous day in the shop. Perhaps there is no department in an engineering works in which apprentices can be kept so constantly employed.

The conclusions to be drawn from the above, with regard to lack of progress in intelligent and industrial education among foundry apprentices, is that it is due to the early age at which they leave school to enter an apprenticeship. Strenuous shop work and want of sufficiently developed intelligence at school prevents real progress at continuation classes. The first important duty, then, which would appear to devolve upon the council and members of this association is to consider how best to raise the standard of the trade in the eyes of the public, so that the apprentices entering the foundry may be, as regards intelligence, equal to, if not better than those entering other trades.

Industrial Education in Germany

In Germany great attention has been and is being paid to the industrial education of the foundry apprentice. Generally, the scheme follows on the lines laid down at the beginning of the paper. In its industrial life it is recognized that one of the most important requisites for the flourishing of an enterprise is a capable staff of workmen, the training of whom is one of the most important tasks of a manufacturing establishment, while at the same time it renders a social service to the country. Many of the large employers maintain apprentice schools within the factory, schools which are of an intellectual and not of a manual character. Apprentices therefore obtain a training in manual dexterity and

*Presented at the Cardiff convention of the British Foundrymen's Association.

skill under strictly apprenticeship conditions, along with intellectual work closely related to the shop work. The advantages of an employer's apprentice school are the saving of time going to and from school and the releasing of employers from the duty of supervising apprentices outside of shop hours. For those apprentices whose employers are unable to run an apprentice school, facilities on the same lines are provided by the municipalities. Ludwig, Loewe & Co., of Berlin, were the pioneers in the formation of an apprentice school some 10 years ago. A short account of their scheme will be of considerable value and interest.

The Ludwig, Loewe & Co. Apprenticeship System

Apprenticeship extends over a period of four years.

Practical Work

Molders:—
Sand cores, nine months.
Loam cores, six months.
Sand molding, twelve months.
Carpentry, three months.
Large sand molding, seventeen months.
Testing and trimming, one month.

Loam molders:—
Loam cores, six months.
Carpentry, two months.
Small loam molding, twelve months.
Large loam molding, twenty-seven months.
Testing and trimming, one month.

School Work

Two afternoons a week; one from two to six and the other from four to six, extending over the whole period of four years.

First Year. — General intelligence, two hours:—The legal relations of the employers and employes; the rights and duties of working men; the history of trade guilds; the relationship of apprentices to the guilds; accident and sickness insurances; patent and trade-mark law; citizenship; reading and correspondence. Drawing, two hours. (Instruction in this subject is specialized for foundry work.) Arithmetic, etc., two hours.

Second Year.—Workshop, two hours: —Construction of a foundry; general arrangement; descriptions of the cupola, machines, etc.; lighting and heating; safety appliances; rules for the prevention of accident; hygiene; comradeship; courtesy; order and peace; payment of, and claim for wages. Drawing, two hours. (Model drawing specially related to foundry work.) Arithmetic, two hours:—Exercises in lighting and heating; transport of raw materials and costs.

Third Year.—Raw materials, two hours: — Materials of construction; their production, classes and properties; forging and rolling, etc.; properties and manufacture of copper, tin, zinc, etc., and their alloys. Arithmetic and geometry, two hours. Special reference to the foundry and model drawing.

Fourth Year.—Foundry Education: —Description of the various foundry tools; molding; casting; cupola practice, etc. Citizenship, one hour:—Constitution of the state and empire; imperial revenues and expenditures; the rights and duties of citizens, etc. Drawing, two hours. (Special reference to foundry work.)

This short excerpt from the syllabus indicates that, while a considerable part of the time is occupied with work directly connected with the practical side of the foundry, the most important side of the education is the development of the true idea of citizenship and general intelligence.

The American Foundrymen's Association, a number of years ago, appointed a committee to handle the question of industrial education. The chairman of this committee is Paul Kreutzpointner, with whom this movement is an earnest lifework. He reports that the national government must come to the relief of the industries in the matter of industrial schools, since it is seen more and more that the industrial education of all the workers—and not only a few of the best ones—has become a necessity to preserve the industrial standing of the nation. The states of New York and Massachusetts have made a beginning—mention in the case of Cincinnati will be made later.

To make any plan of industrial education effective there must be earnest good-will and co-operation of educators, the manufacturers and business men, and the workmen themselves. This industrial education must be used not only as a means of imparting mechanical skill, but also to raise the ideals of citizenship and act as a socializing agency.

The Cincinnati System

Mention has been made regarding the system which has lately been put into operation at the University of Cincinnati, for the training of foundrymen. The system is briefly as follows:

Careful selection of high average quality of raw material by university and shop.

Students work at the university and shop on alternate weeks.

Students grouped in pairs; members alternate with each other in shop and university; both shop and class rooms are thus always manned.

Student does same class of work as a regular apprentice, and under same shop discipline. If expelled from the shop, he ceases to be a student of the university.

The student is paid for his work in the shops.

A shop schedule is arranged between the university and shop authorities, and in accordance with this, a student is moved forward through the various departments of the shop.

Students' school work is identical in standard with that given in all high grade engineering schools. The shop instruction and certain laboratory courses, which would be but a duplication, or rather, a poor imitation of the experience the boys are getting in the shop, are omitted.

The course is five years in length.

Co-ordination Work

In the opinion of Mr. Porter, who had charge of this work, the most interesting and valuable feature of this course is the shop co-ordination work which has for its object the taking of the blinders off the boy, helping him to see the real meaning of the operations going on about him in the shops and giving him an excellent benefit from shop experience; for example, if he has been on the cupola platform, the subject of pig iron may be taken up, while at another time, the theory of the cupola may be explained. An effort is also made to introduce the student to the best literature of the foundry. The great value of this feature of the work enables the student to better understand shop methods and processes, but it stimulates his interest in his work and helps to cultivate in him habits of observation. About a dozen of the leading foundries of Cincinnati and vicinity are giving their cordial co-operation to this scheme.

The Foundrymen's Association, of France, encourages the raising of the standard of foundrymen by offering money prizes for papers dealing with foundry problems; but no definite information can be obtained to show that the French educational authorities or employers are doing anything to systematize the industrial education and training of foundrymen.

Killing Molding Machines to be Built by Davenport Machine & Foundry Company.

The Davenport Machine & Foundry Co., Davenport, Ia., has purchased the molding machine business of the E. Killing's Molding Machine Works, of that city, and will continue to manufacture this extensive line of foundry labor-saving devices. The Davenport Machine & Foundry Co. is well equipped to manufacture these machines and has ample facilities to insure prompt deliveries. A. J. Goss, vice president and manager of the Killing company, has been appointed sales manager of the molding-machine department of the Davenport Machine & Foundry Co.

Making Steel Castings for the Panama Canal

Description of the Tropenas Converter Installation at Gorgona, With a Brief Reference to the Gray Iron Shop

TO MAINTAIN the efficiency of the mechanical equipment employed in the construction of the Panama canal, repair shops of considerable magnitude are required. These departments are not concentrated at one point, but are divided into a number of individual units which are located at convenient points along the line of the canal, each plant being equipped with special reference to repairs of the particular type of machinery at work in its vicinity. Thus the shops at Balboa, at the Pacific end of the Panama canal, are devoted largely to the repair of the various dredges and other marine equipment employed. These shops were originally built by the French, and much of the old equipment is still in use. The shops at Empire are engaged almost entirely on steam-shovel work, making repairs and rebuilding the shovels if necessary. The shops at Gorgona repair railroad equipment and operate foundries for the production of gray iron, brass and steel castings.

The steel casting plant at Gorgona was erected in 1911 and is the most recent addition to the repair equipment. It was established because of the delays experienced in securing steel castings from the foundries in the United States and to obviate the necessity of carrying tons of cast steel repair parts in stock by the quartermaster's department. The lack of equipment to make steel castings had been found a great inconvenience and many repair parts that should have been made of steel were cast of iron or brass. Steel-making, however, involved a greater problem than the production of either iron or brass castings, owing to the shortage of raw materials and the impossibility of operating on a continuous basis.

FIG. 1—THE TROPENAS CONVERTER IN OPERATION

The contract for the equipment of the steel foundry was awarded to the Tropenas Converter Co., New York. A standard, 2-ton converter equipped with a knock-out bottom attachment, was installed. The construction of the converter bottom permits the vessel to be operated daily. Blast for the converter is furnished by a high-pressure blower driven by a 75-horsepower motor.

The iron for the converter is melted in two 10-ton cupolas and the metal is transported by a 25-ton traveling crane. One 4-ton and two 2-ton crane ladles have been provided. For pouring the smaller molds the equipment consists of eight 150-pound hand

FIG. 2—GENERAL VIEW OF THE STEEL FOUNDRY OPERATED BY THE PANAMA CANAL COMMISSION AT GORGONA, CANAL ZONE

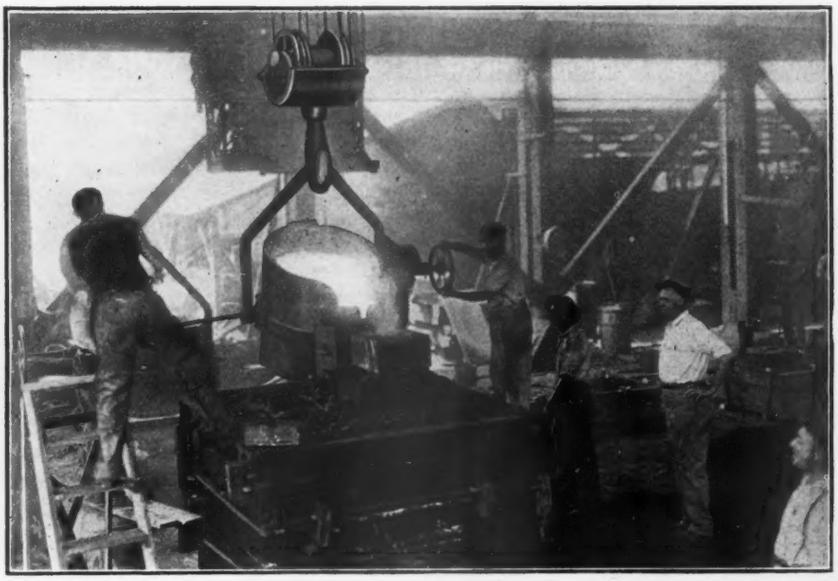


FIG. 3—POURING A LARGE STEEL CASTING

ladles. For drying the ladles there have been installed two oil-fired ladle heaters, one of which is shown in operation in Fig. 6. A general view of the steel foundry is shown in Fig. 2. At the right of the illustration, a large mold made in an iron flask is being shifted by the traveling crane. In the background the converter is shown in operation and at the rear of the converter the cupolas are located. The crane operator's cage is shown at the left, and it will be noted that the head room underneath the crane is limited by the comparatively low roof of the building. Fig. 3 shows a large mold being poured with converter steel. The steel is being poured from a lip ladle in place of a ladle of the bottom-pour type usually employed in steel foundries. A large steel casting, weighing 6,500 pounds, which required two successive operations of the converter to obtain sufficient metal to pour, is shown in Fig. 5. For preparing the facing sand, a double-roller sand crusher and mixer has been installed. A view of the mill, which is motor-driven, is illustrated in Fig. 4.

The gray iron foundry at Gorgona has a monthly output ranging from 350 to 400 tons of castings for repair work. Castings also are made for contractors building the locks at Gatûn. The casting production for this purpose during 1911 was 1,000 tons. Most of the castings used by the contractors are, of course, shipped from the United States, and some idea of these requirements is indicated by the contract for the lock gates. Forty-six gates having two leaves each are being installed and each leaf of the largest gates weighs 1,483,700 pounds.

For the construction of these gates, 9,247,000 pounds of steel castings, 406,000 pounds of iron castings and an enormous tonnage of structural steel was required. The steel foundry has proved a great convenience to the contractors as it enables them to replace missing or broken parts in a much shorter time than they could be obtained from plants in the United States.

Construction work on the canal is being prosecuted under such great pressure that it is necessary to main-

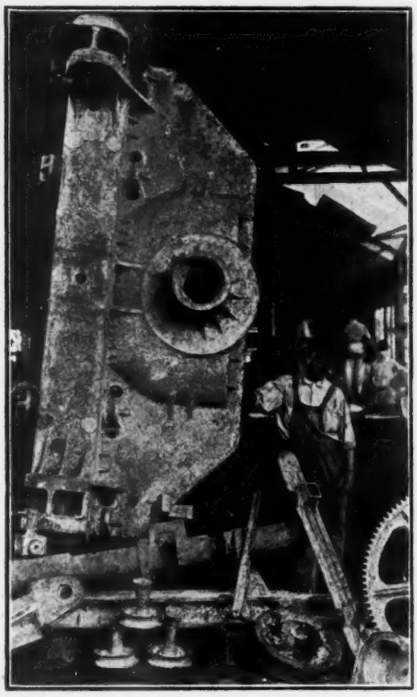


FIG. 5—A 6,500-POUND CASTING MADE IN THE STEEL FOUNDRY

FIG. 4—ELECTRICALLY DRIVEN SAND GRINDER

tain all of the equipment in a perfect state of repair. All of the machinery is carefully inspected to locate incipient weaknesses, thereby preventing serious breakdowns. It is not always possible to avoid such accidents, however, as is illustrated by the recent accident to the Corozal, the largest ladder dredge in the world. The dredge was excavating a 25-foot bank of stratified clay and sand stone, when the main driving gear broke. The gear was 14½ feet in diameter, 2 feet wide and weighed 20 tons. It was made in two parts, the gear rim having been cast separately from the wheel to the circumference of which it was attached. The accident resulted in the breakdown of every spoke of the wheel, leaving the hub

entirely free. A new casting was made in the Gorgona foundry, the broken parts of the wheel having served as the pattern. The casting was successfully made, which reflected great credit upon the management of the foundry, as it was an especially difficult piece of work. The casting was machined at Empire and was placed in position on the dredge after a few days' idleness. As the dredge was built by William Simpson & Co., Renfrew, Scotland, a gear would have had to have been obtained from this company if facilities for making repairs had not been provided.

Korean Graphite Exports

Statistics of the exports of graphite from Korea, referred to in the article entitled "Mining and Sorting Graphite in Far-off India," by Chas.

FIG. 6—FUEL OIL, CRANE LADLE HEATER

E. Pettinos, published in the August, 1912, issue of THE FOUNDRY, have been corrected by Mr. Pettinos as follows:

	Tons.
1908	4,772
1909	6,451
1910	4,841
1911	4,370

These are the first accurate figures obtainable regarding the graphite exports of Korea and were received too late to permit of making corrections in the original article. Korean graphite in common with amorphous Mexican graphite, has proved an excellent product for certain kinds of lubrication, polishes, etc. This graphite compares favorably in structure, fire test and purity with the highest types of amorphous graphites produced elsewhere.

Frederick Baldt Jr., formerly associated with the Nelson Valve Works, Wynmoor, Pa., has been appointed superintendent of the plant of the Keystone Steel Castings Co., Chester, Pa.

Instructions for Making and Casting Nickelene or Silver Metal

By A. L. Goldsmith

Considerable difficulty is frequently experienced in casting the alloys of nickel and copper, known as nickelene, nickel silver or silver metal, as the castings exhibit a strong tendency to run spongy or porous, and to also draw or shrink in the sharp corners, or wherever a heavy and light section are joined. In addition to the excessive contraction which causes the castings to break while being finished, the metal is hard and difficult to machine.

The machining properties were improved by reducing the content of nickel, and the shrinkage and drawing were overcome by the use of suitable gates, shrink balls and by regulating the pouring temperature of the metal. The accompanying illustration shows a half mold containing several simple check discs for valves, and these castings were the source of much trouble as they invariably contained a draw or shrinkage crack at the point of juncture of the stem and disc. This difficulty was overcome by placing a shrink ball on the end of the stem. Shrink balls must always be used in making castings from this alloy, and these should be of such a size that they will remain fluid after the casting has set, to supply metal for the shrinkage of the casting.

In addition to the use of shrink balls, it is advisable to avoid all sharp corners on either patterns or cores, as the hot metal has a tendency to cut or wash away the sand at such points, especially if green sand molds are used. While wide, thin gates are better for brass, nickelene requires deep narrow gates, otherwise a draw or a shrinkage crack will result.

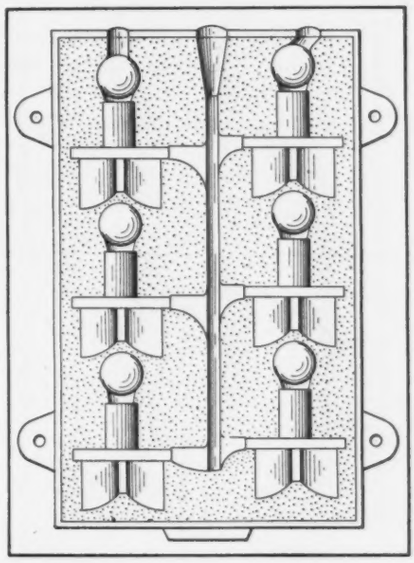
The principal object in using nickelene or silver metal, is to obtain castings of a uniform white color, which will withstand repeated polishing without change of color. This is not the case with plated goods, as the nickel is worn off by the friction of the polishing compound, and exposes the base metal underneath.

Silver Metal Formula

To match tubing and nickel-plated ware, the following formula has been found most suitable by the writer:

	Pounds.
Copper	55
Nickel	12½
Zinc	20½
Lead	10
Tin	2

The nickel may be in either shot or disc form, and the alloy is made by first placing the copper and the nickel in the crucible together, keeping them well covered with charcoal or coke dust, and as soon as they are melted, the soft metals are added. The furnace then should be urged until the metal is so hot that it will bite into an iron bar, at which stage a piece of magnesium, about ¼ inch square, or a small piece of aluminum should be added. The former deoxidizer is preferred. When adding it to the bath it is tied to an iron bar and plunged to the bottom of the crucible, the metal meanwhile being vigorously stirred. The crucible should then be removed from the furnace, skimmed and poured. After the first mold is poured it will be well to take note whether the metal rises or swells in the sprue, and if



VERTICAL SECTION OF AN UPRIGHT MOLD OF VALVE CHECKS, SHOWING GATES AND SHRINK BALLS REQUIRED FOR CASTING NICKEL SILVER

it does, an additional piece of magnesium or aluminum should be added. However, care should be exercised to prevent using too large a quantity. In all cases where the sprues swell or rise in the center, the castings should be scrapped as they will be found defective when machined. In pouring this alloy, the metal should be hot enough to smoke like yellow brass, otherwise the castings will be very liable to leak when tested. When poured at this temperature it was found that the tendency to shrink and crack was materially reduced.

The Osceola Silica & Fire Brick Co., Pittsburgh, is installing a new fire clay mill in its plant at Osceola Mills, Clearfield Co., Pa.

Patternmaking Economies and Developments*

The Pattern Considered as the Molder's Tool and the Necessity for Accuracy in Construction is Emphatically Pointed Out

By T R Schofield

WHEN engineering made its first great advance, considerations of economy and expedition caused the patternmaker to take his place as a specialist in this branch in succession to the old-time mill-wright; since then, progress has been very rapid, but generally speaking, the same motives which made him a specialist continue to be a controlling factor in deciding on the correct form which his work shall take.

The wisdom of his decision is not in question in the case of simple elements, when the pattern is merely a facsimile of the required castings,

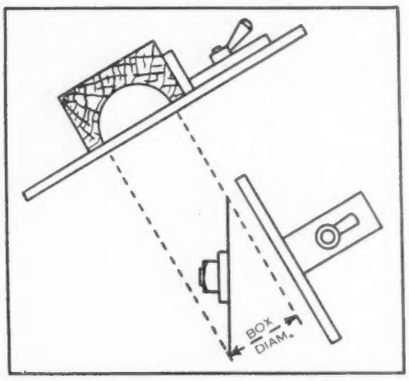


FIG. 1 — ROUGHING-OUT A SEMI-CIRCULAR HALF CORE BOX

though sometimes such patterns are rather more ornamental than useful, bearing evidence that time has been spent imparting a fine finish, which could have been devoted to gaining a more accurate conception of the purpose for which the pattern was made.

In castings of more complex form, however, the design usually admits of several methods of molding, and the advisability of the use or avoidance of cores and drawbacks has to be settled before the pattern is begun; then the decision arrived at assumes a considerable degree of importance to the foundry concerned. Errors of decision in these elemental matters frequently involve the foundry in expenditure of labor which might be avoided. It is of paramount importance, therefore, that the patternmaker should possess a tolerably exact knowledge of foundry practice and foundry economy, in order that the patterns provided shall involve a minimum of labor to produce the molds and cores. The first problem which the patternmaker has to solve, then, is the finding of that particular way, of all the possible ways by which a casting can be made, which shall fulfill the requirements of the foundry to the best advantage.

Former Methods

In time past, when patterns were laboriously hand-made and the conveniences now common in up-to-date pattern shops for rapid production were almost unknown, many ingenious methods were evolved, enabling castings to be obtained from a somewhat meager pattern preparation. Such castings were not always as true as might be desired; some of the niceties of design had to be sacrificed and allowance for machining had to be somewhat generous, to cover inaccuracies. Still, such methods and such castings suited the needs of the time. Contingencies still occur when these makeshift methods are justifiable even at the present time, as, for instance, the familiar one-off job in some of its forms, and the bona fide breakdown. Knowledge of these cheap methods formed no small part of the patternmaker's stock-in-trade, but they have tended to become stereotyped into standard methods.

If it is granted that real patterns are essential to bring us nearer to the ideal of foundry efficiency, in conjunction with the enormously increased facility with which a pattern can now be made for a correspondingly reduced cost, it is evident there is not now the same justification for adoption of makeshift methods as formerly, and that continued persistence in such methods constitutes a serious bar to legitimate foundry progress.

The past 10 years have witnessed intensified concentration on the part of engineers, in those spheres which are peculiarly theirs, namely, the efficient utilization of natural sources of power and the acceleration of production. Among prime movers we now have, for very high powers, the steam turbine and internal-combustion engines for both gas, oil and spirit, placed upon a commercial basis. Increased efficiency, higher speeds of rotation, and higher range of temperatures; also the cutting-down to a minimum of clearance spaces, have resulted in increased complexity in the castings forming the principal elements of these engines, and have brought into prominence the need for greater precision and uniformity in such castings than has ever obtained before. Leaky joints and much expensive machining and fitting are obviated by combining in a single casting, whenever possible, elements which have hitherto been made separately; these com-

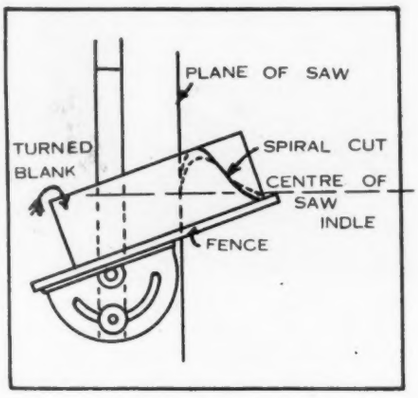


FIG. 2—CUTTING THE THREAD ON A PATTERN FOR A WORM

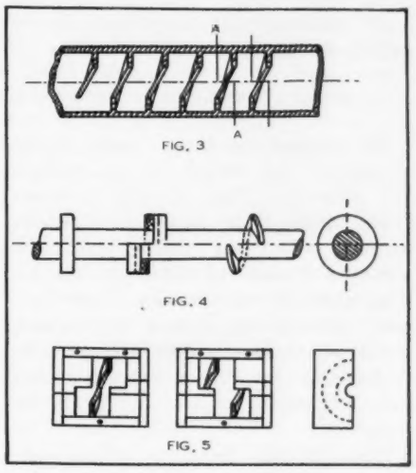
binations are characteristic of the time, and involve both the foundryman and patternmaker in greater responsibility for their satisfactory production.

In the sphere of rapid production, the scientific study of the principles underlying the best use of metal-cutting tools, and the introduction in recent years of high-speed steel, have completely revolutionized the design of machine tools. All-gear drivers, quick-change gear boxes and other time-saving, production-increasing features incorporated in their design, have transformed the simplest of them into more powerful, more productive, more nearly automatic machines.

Standardized methods of handling castings in quantities for machining.

*Presented at the Cardiff convention of the British Foundrymen's Association.

to reduce costs, with the need for interchangeability, have resulted in the application of jigs for all possible purposes, and only serve to emphasize the need which exists



FIGS. 3, 4 AND 5—SECTIONS OF A CORE BOX FOR AN INTERNAL CONVEYOR SCROLL

for the highest degree of precision in the castings supplied.

It would seem reasonable to deduce from the foregoing, that those concerned in the economical production of castings, in order to fulfill the requirements indicated, embodying great intricacy and precision, have no small part to play in the maintenance of progress. My concern is with the attitude of the patternmaker to these developments, how, incidentally, the foundry is affected through him, and what can be done to insure that he shall efficiently discharge his functions as a worthy member of the advanced organization of the engineering profession.

False Economy in Patternmaking

The work of the patternmaker leaves him with more scope for the exercise of initiative than almost any other branch of engineering; it is under his hand that the work of the designer first finds tangible expression, and he is frequently entrusted with a large measure of discretion and enjoys opportunities for intercourse and suggestion with the designer. The live designer does not despise his suggestions; the tangible expression above mentioned often takes forms which render it almost unrecognizable to the designer, who has to take him somewhat on trust, and in whom are induced feelings of respect because of the uncertain factors which seem to surround the evolution from drawing to casting.

Many of the qualities which characterize the designer are also found in the successful patternmaker; both perform certain duties which are but steps toward a final achievement; the actual work of each has no place in the finished product, and for this reason both enjoy the distinction of being called non-producers. Some enthusiasts have carried the thought further, and styled both as necessary evils, and I have frequently heard the patternmakers' frame linked with that of Ishmael; so that their pursuits give them ground both for mutual respect and sympathy.

From time immemorial, money spent on making patterns has been regarded in many quarters as lost beyond recall. Certainly money spent on superfluous or unnecessary work in any department is loss, but the necessity which exists for efficient patterns surely displays the inconsistency of such an attitude. The foundations of true economy must be laid, not upon such prejudice as above mentioned, but by paying the same attention to the equipment of the pattern shop and the methods of producing the patterns as has proved so successful in the productive departments.

Pattern—The Molder's Tool

A pattern is a tool provided for the molder's use, but unlike most tools, it is used in a somewhat spasmodic manner. Such patterns as are used more or less continuously, in other words, standard patterns, are worthy of receiving every possible attention, regardless of cost, since this is relatively small. Most patterns, however, are not used so frequently, and for this reason the relative cost increases accordingly. In any case, good castings, involving minimum labor in the foundry, and with allowances so fine as to require the minimum time for machining and fitting, demand patterns made to some recognized standard of quality. When the saving in first cost of a pattern is outweighed by the cost of extra labor in the foundry, the pattern ceases to be a cheap one.

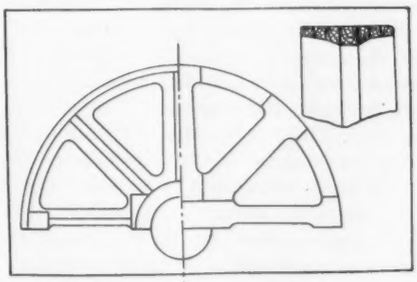


FIG. 6—A QUICKLY-MADE HALF-WHEEL PATTERN

The desirable quality of a pattern, then, is measured by the facility with which the mold is produced from it. Its purpose is strictly utilitarian, and superfluous work is to be deprecated. With a reasonable standard of efficiency adopted, the cost need not be prohibitive if proper equipment is provided and up-to-date methods adopted to produce the patterns. In analyzing the various operations necessary to make a pattern, it is my intention to show in how many ways mechanical operations can be used instead of hand operations, with an enormous reduction in cost.

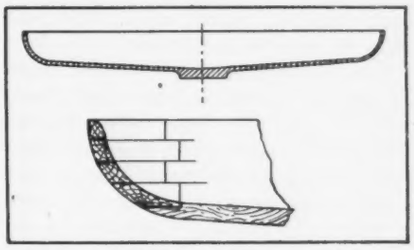


FIG. 7—SECTIONAL VIEWS OF A TROUGH PATTERN

Where a broad view of economy in pattern cost is taken, so as to embrace the foundry and subsequent departments handling the work, a higher standard of finish is secured in the castings, production is enhanced, and the foundations laid for realizing more fully the great potentialities of the foundry.

Patternmaking and Equipment

The work of the patternmaker might be roughly divided under the following heads:

Planning or previous study of methods.

Machine work of sawing, planing, turning, etc.

Setting-out and building.

Handwork of paring, carving, filleting and sand-papering.

As previously mentioned the method decided on from a preliminary study of the drawing, has more than a passing interest to the foundry concerned, since that department ultimately suffers from errors of decision at this juncture. A thorough study of the drawing by the foreman patternmaker enables inconsistencies in design to be corrected, and modifications to be made to simplify the work both in the pattern shop and the foundry. For instance, the hollow box section, beloved of machine designers, frequently necessitates cores either suspended in the cope, or insecurely balanced on chaplets in the drag, these chaplets often being cast into faces requiring to be machined, thus add-

ing to the troubles of the machine shop. A timely suggestion being made, the designer cannot fail to appreciate the force of the argument, and small but efficient apertures are provided, insuring proper support in prints for the core, efficient venting and satisfactory results. Instances could be quoted where, from a single suggestion, the whole design has been altered, with a considerable gain in all-round efficiency.

The planning of the pattern must be, above everything, thorough, and embrace all the essentials of the construction and subsequent molding; the foreman's decisions should be modified, as occasion arises, by consultation with the foundry head whose advice and co-operation are of prime importance in securing the best results, and in avoiding those vexatious alterations to patterns often made necessary when found unsuitable to foundry conditions.

Layout of the Work

The preliminary work done, the job can be put in hand, and if accompanied by explicit instructions the patternmaker can proceed in a direct manner with the work, unhindered by doubts or fads, progressing more rapidly with it than if it were imperfectly thought out and difficulties left to be overcome as they presented themselves, which is not the modern way. It is a mere commonplace to say that economical production is secured in any branch of business by a proper planning beforehand of the work to be done, and possible difficulties as far as possible anticipated and provided for.

In work of a more or less intricate nature, involving the use of many cores, a full-size layout of the job on a board proves most helpful. Machining allowances can thus be shown; troubles in connection with the swelling of baked cores can be to some extent provided against by allowance for this being indicated on the layout, and the energy expended in rubbing cores to fit prints can be reduced if not eliminated.

With the use of a layout, a large job may often be sub-divided to advantage, individuals each handling separate units which together make the complete pattern. By this means precise methods of execution can be employed and much economy of time effected.

The machines provided for the use of patternmakers are the same general type as usually applied to woodwork and include machines for sawing, planing, turning and grinding. All of these are a practical necessity where a fair quantity of work is handled. Machines specially adapted to modern shop needs are available and only require intelligent handling to justify their installation.

The modern circular dimension saw is a precision tool; it carries two saws on separate spindles, capable of being operated alternately, by means of a handwheel movement. The height of the saw above the table is adjustable from zero to about 4 inches; the fences or work guides for ripping and cross-cutting and the work table itself, are designed to make the machine as universal in application as possible, each being capable of an angular movement of half a right angle, a few seconds only being required to set up for a job. These features enable straight work to be cut dead to size and angle, and worked into the job without the necessity of an intermediate handling. For example, a framed core box is made in a few minutes, with the ends cut off to the correct length with allowance for draft, and checked into the sides. Polygons for hollow cylindrical patterns, and the lags for the same, require very little further attention; in fact, these machines are so valuable that one is led to think that it might be an advantage to have a small edition of them placed at the end of each bench, ready for the thousand and one jobs on which it is prepared to demonstrate its efficiency.

Interesting Jobs

Two jobs of rather an unusual nature may be worthy of mention here, as showing the term circular saw to have in this connection a meaning deeper than the conventional one. The first is the roughing-out of a semi-circular half core box, Fig. 1, or similar work. The rip or coarse-tooth saw is set so that its highest point is above the table at a distance equal to the radius; the ripping fence is then swung out of its normal position, which is parallel to the plane of the saw; the angle which it makes is determined by measuring from the extreme points of the saw blade at table level perpendicular to the fence; the fence is correctly set when the difference between these measurements equals the diameter of the box, or double the height of the saw above the table. The patternmaker with mathematical tendencies might calculate the angle as follows: Let D = diameter of saw, d = diameter of box, then $\frac{1}{\sqrt{D/d - 1}}$ gives the sine of the required angle when the actual values are substituted. The setting accomplished, the saw is lowered, and the interior of the box is cut out by a series of successive cuts, the saw being raised about ¼ inch each time. The final cut is not quite circular, but very little labor suffices to make it so.

Cutting a Thread on a Pattern

The second job for the saw is the cutting of the thread on the pattern for a worm, Fig. 2. The conventional method is to wrap a paper templet round the worm blank, on which is drawn the straight line development of the thread; then follows the relieving out of the thread, about as tedious a job as we have to handle. By this method the pattern is very expensive and not very accurate.

This job can be done on the circular saw without any setting out, and with variation of pitch not exceeding one-hundredth part of an inch. The shallow-tooth cross-cut saw is set above the table an amount equal to the depth of the thread. The turned blank is supported against the cross-cutting fence, whose normal position is perpendicular to the plane of the saw, and slides in a groove parallel to the saw; this fence is then turned through an angle equal to the angle of advance of thread. The tangent of this angle equals $\frac{\text{pitch}}{\text{circumference}}$. Some adjustment has to be made, and the blank is made 3 inches longer to allow of one or two trial cuts before going through.

The blank, held by the left hand against the fence, is pushed forward with the right until directly over the center of the saw, when the saw will have penetrated the full depth of thread; endwise movement of the blank is prevented by the saw blade. If the fence were square to the saw and the blank twisted around by the hand, a groove would be cut all around. The fence being inclined, however, the blank is rotated with the left hand, and feeds endwise, a spiral cut of the required uniform pitch resulting. Two such cuts are necessary, one for each side of the thread. Some hand labor is still required to give the taper side to the thread, but it is putting it moderately to say that the total time is reduced to one-half, probably one-third, by this operation which itself takes less than half an hour.

The planing machine is so familiar as to need little comment. We rarely find means provided by which timber

may be planed to parallel thickness; where jointer and thicknesser are provided, either separately or combined as one machine, hand work of this kind is almost eliminated. If due care is taken of the cutters, many jobs such as wheel rims and other circular members may be built up with good joints, without any hand planing whatever, a matter which is worth considering as one of the many economies that can be effected.

Sandpapering Work to Shape

To sandpaper one's work to shape was anathema to the preceding generation of patternmakers; we are now, without shame, grinding to shape a big percentage of our work, large and small, on the sanding disc, with results satisfactory to all concerned. The saving in cost is enormous, and its use enables many novel modes of construction to be applied, which, with the invaluable aid of leather fillets, secure the desired form and finish in a much more direct manner than is possible with hand labor. No pattern shop is complete without the sanding disc; it would be impossible to enumerate in how many ways it is advantageous, for it embraces in its scope nearly every detail of a pattern. That it is not a toy may be gathered from the fact that wheels of all sizes, up to a foot wide, are ground to shape, with correct draft, from the rough, with the speed which puts the lathe to shame. The lathe has been put partly out of commission with the advent of the sander, but has been compensated in our case by a suitably large face-plate and tilting table attachment for the lathe, thus combining in one machine the functions of both, and forming an inexpensive and efficient arrangement.

One might also mention, in passing, that lathes with wooden beds are not ideal for doing good work. Cases have been known where work a little too large has been accommodated by a little relieving out of the lathe bed; such a practice pursued for long can only end in disaster. Even where iron beds are provided, one looks in vain for the slide rest, which is as invaluable for turning wood as for most other materials, where precision and time are of importance. One can only wonder, and hope for the best.

It has always seemed to me, since a casting cannot be more accurate than its pattern, that the pattern deserves every care devoted to insure that faces shall be truly perpendicular, and shaft centers bear their proper relation to each other and to the faces. To insure this, the setting-out table of the fitting shop, with accessories in the form of angle plate and scribing block of adequate size, are an absolute necessity in the pattern shop. Where these facilities are provided, the work of building-up the pattern, whether it be a wheel rim or a machine or engine bed, is greatly expedited; machining allowances can be cut down to a minimum, and, in short, all the advantages realized of using precise, in place of rule-of-thumb methods.

In the foregoing remarks, I have tried to show that foundry efficiency demands a high standard of quality and completeness in the pattern. Also that patterns capable of meeting this demand satisfactorily, while insuring castings on which a minimum of labor is necessary to machine and assemble, need not be prohibitive in cost, if methods are studied and equipment adapted to suit present needs.

Tube and Internal Conveyor Scroll

The interest of the patternmaker in his work is never more keen than when engaged on work of a somewhat unusual character, and possibly no class of work is more interesting or so puzzling to the outside observer, as that in which are used assemblages of cores. The tube illustrated in Fig. 3 is of this kind; it was required to be of cast iron, ½ inch thick throughout, 8½ inches outside diameter, and 53 inches long. The clear bore was 3¾ inches diameter, so that the thread was 1⅞ inches deep, the pitch being 3¾ inches. Only a few castings were required and a corebox the full length would have been not only expensive but a mass of loose pieces, difficult to locate in the box, without any advantage to the coremaker. The method adopted was cheap in patternmaking, and provided the foundry with a number of compact cores, quickly made and readily assembled to form the completed core.

The castings did great credit to the foundry and were uniform, smooth and without chaplets, a necessary feature as the tubes were subjected to great heat. The pattern was simply a plain cylindrical model, with prints at each end to carry the core. The core box contained one complete thread and 10 cores for the complete core. The first and tenth cores differed from the rest, which were all alike.

The joint between the cores required attention, as a plain face would give feather edges and be unworkable; for that reason the face was formed with a step equal to half the pitch, *AA*, Fig. 3, which overcame this difficulty, and had the additional advantage of one position only in assembling and imparting stiffness to the finished core.

The box is shown in Fig. 5; the holes in the ends received a 1½-inch print, the diameter of the barrel on which the core was built. The thread was made in four pieces; four equal segments were built on a parallel block turned to 3¾ inches diameter forming a circular flange, 2 inches thick. This was turned to fit the box, 7½ inches in diameter. Three of these pieces were then moved along, each ⅞ inch (one quarter the pitch) in advance; two parallel helical lines were then set out, ½ inch apart, and the faces of the thread pared out by hand, these faces being square with the turned block at all points. The true form of thread was thus secured. Before removing from the block the positions of the thread sections were scribed in the box, making easy their ultimate location and securing. Blocks at each end of the box gave the staggered face to the core; for the end cores these blocks were removed alternately and pieces inserted to give the required forms. The cores were, of course, made in halves and glued together, being afterward built on a barrel, and finished off, a very satisfactory core being obtained.

A Quickly Made Half-Wheel Pattern

The advantages of modern methods are best appreciated in the case of the hurry-up job. The wheel shown in Fig. 6 is a case in point. It was 40 inches diameter and had 72 teeth, 1¾-inch pitch, which had to be relieved to insure soundness. The width of the face was 12 inches. The teeth, though only rough approximations in form, had, of course, to be correctly spaced. The pattern had central arms, ribbed up to the rim, bosses 12 inches in diameter for four bolts, and bolt lugs at the rim. It occupied in making, 10 hours by three men.

First a part plan and section were laid out full size on a board, and all possible information shown to expedite work; machining and draft allowances were shown, also thicknesses of timber, and, as far as practicable, other details of construction of the pattern. This preliminary work enabled the job to be efficient-

ly subdivided, and the work on each detail to be proceeded with directly, and completed before assembling.

No hand planing was done whatever, except circular planing of the inside of the rim segments after these were cut with a band saw and bevel. The central plate arms were first assembled, the parts being adequately secured with corrugated fasteners, which are indispensable in the pattern shop. The rim segments were then built on this, attention being devoted only to the inside, to eliminate subsequent dressing off as far as possible. When the rim was built the sander table was set to give 1/10 inch taper, and the outside of the rim ground down to size. The working-in of the bosses and ribs proceeded while the teeth were being spaced-out and attached. The method of previously planning the job caused a single cut at every point to suffice, instead of a roughing-out somewhere near, with a more or less generous allowance for finally working to size. In this way much time is saved.

Trough for Large Automatic

Most patterns are successfully handled by first constructing a stiff foundation which forms a part of the job; this foundation is usually either a solid block, a frame, or a box, sufficiently stiff to be relied upon while the superstructure is proceeded with. Many others are of such form and light character as to be incapable of standing alone until near completion; cases are on record where even the final coat of paint has been relied on to impart the necessary stiffness, and are somewhat analogous to the villa which is so scientifically built as to rely on every element of paint, lath, plaster, and internal paper for stability. A more desirable analogy is that of the arch, only supported until the keystone is inserted, and then capable of displaying stability for all time.

The trough illustrated in Fig. 7 was of the kind needing to be supported until practically complete; its keel was laid on the shop setting-out table, and there it remained until fit to be moved; its dimensions were roughly 6 x 3 feet, metal ½ inch thick with 1½-inch fall to the center for drainage. The large-radius sides and corners, and the hopper form of base, made it a more difficult job than might appear. Details of construction were taken care of by previous layout and planning as far as practicable. The base was first built of four triangular frames, half-lapped together on the saw; the vertices converged at the center, and rested on the table, the outer edges being raised on 1½-inch parallel packings; this gave the right hopper form to the base. The 6-inch radius was made in four straight lengths, and one full circle turned for the corners, which were cut out with a fine saw, giving the four quadrants. These elements were, after finishing the inside faces, united as shown, similar to brickwork bonding; this was facilitated by all timber being machine-planed to one thickness. Rebates were cut around the base to receive the molds and to provide the necessary thick edge to the radius. Seatings for headstocks, bosses, facings, etc., are not shown, but were accurately placed with the aid of an ample scribing block working off the table face. The castings required were made without need of an iron pattern, and the pattern continues to justify the care spent on its construction, survives storage without shrinking or warping, and costs little for repairs.

The Loss of Skill in Founding

Thos. D. West, 10511 Pasadena avenue, Cleveland, is conducting an investigation to ascertain to what extent skilled molders are being replaced by molding machine operators. Mr. West solicits information on this subject from firms engaged in iron, steel, brass and malleable foundry work and would like to receive replies before Sept. 25 to the following questions: Class of work made, number of molders making molds by hand and number of employes operating molding machines. The data thus obtained will be treated confidentially and will form the basis of a paper which Mr. West will read before the New England Foundrymen's Association in October entitled "The Loss of Art and Skill in Founding."

The air furnace in the gray iron foundry of the Bethlehem Steel Co., South Bethlehem, Pa., although of the type usually installed, is constructed in a novel manner. The bed is so designed that it slopes toward the hearth end, instead of toward the flue, the tap hole being located at the hearth end. By this construction, although the results are the same, it takes a longer period to raise the iron to the desired temperature. This furnace has a capacity of 13 tons and is employed by the Bethlehem company only for producing high grade iron for special castings.

Clean Stove Plate

By W. J. Keep

Question.—We are experiencing considerable trouble in getting our stove plate to peel properly. We use both local and outside sands, but the result is invariably the same. We are using the best heavy and return facings obtainable, but the castings will not peel properly. We are of the opinion that the cause of our difficulty can be traced to our iron mixture.

Answer. — The sand should be sufficiently refractory to prevent it from burning into the iron. A high percentage of silica is required in sand for this purpose. The facing, also, is an important feature. The light facing is used merely to prevent the heavy facing from adhering to the pattern when it is returned. We would suggest that you try the best quality of silver lead obtainable. Of course, the most important feature of all is the iron mixture. Peeling of the sand from the casting is effected by the graphitic carbon contained in the iron which is exuded from the iron as it cools and is deposited between the surface of the casting and the heavy facing which was dusted onto the mold. The light facing is burned off as soon as the hot iron comes in contact with it. The exuded carbon is a facing of pure graphite forced from the iron. It is, therefore, necessary that your pig iron should contain at least 3.50 per cent carbon. The reason that this melted pig iron drops some of its carbon is because the melting temperature is not as high in a cupola as in a blast furnace and, therefore, it is due to the fact that for producing a good stove plate mixture, the silicon is increased by the addition of a high silicon iron which reduces the capacity of the mixture to hold carbon. To produce the best surface, increase the silicon of the mixture to 3 per cent or more. The phosphorus should be at least 1 or even 1.25 per cent. Melt the iron as hot as possible, but pour at a reduced temperature. The high phosphorus makes the iron fluid at a low temperature. Hot melting holds the carbon in the solution and permits the dirt and slag to float so that it can be skimmed off readily. Pouring cold prevents the sand from burning into the surface of the casting except at the gate. The high silicon causes the iron to throw out carbon as it cools, forming a thin layer of carbon between the casting and the sand, permitting the latter to drop off when the casting is shaken-out. A very small amount of silicon also is thrown off, which helps to impart a silvery surface on stove plate. If you use southern iron principally, the surface will be very light and silvery.

Electric Induction Furnace for Cast Steel*

The Roechling-Rodenhauser Type, Which is in Extensive Commercial Use in Europe — Cost of Making Steel

By C H Vom Baur

THE electric induction furnace for making steel has been in regular commercial operation in Europe for over 10 years and more than 30 of these furnaces have been installed. It can be built in sizes of 8 or 16 tons capacity and 30-ton furnaces have been projected. These electric furnaces are of the Roechling-Rodenhauser induction and resistance type, operating on single, 2 or 3-phase, alternating current, utilizing any convenient voltage of commercial circuits; 25-cycle is preferred, but 60-cycle current can be used in the smaller sizes.

The furnace action is similar to any ordinary transformer. The primary coil receiving the incoming current is subdivided into series of steps, usually five, which by the aid of a switch, regulate the current and consequently the heat in the metal bath. Seventy per cent of the secondary current is induced directly in the bath which is really one short-circuited turn of the secondary winding of the transformer. The remaining energy, 30 per cent, is induced in a large copper-bar secondary winding, wound directly over the primary winding, which receives the electric current from the alternator. This auxiliary secondary current is carried to two steel pole-plates, set beneath the lining, one at each end of the bath. The magnesite lining covering these plates is the hearth of the furnace and becomes the conductor of electricity when red hot, acting similarly to the filament of a Nernst lamp. There are, therefore, two sets of currents in the bath, the main or induced current and the auxiliary induced or resistance current. The advantage of having this combination of electric currents is manifold—it increases the thermal and electric efficiency of the furnace, increases the heat of the steel in the main hearth, thus facilitating the refining and precludes any interruption of the current flowing through the metal. There are, therefore, no involuntary fluctuations of the current, which is consumed at an absolutely steady rate.

The heat of the metal can be kept at any practicable temperature between a dull red and 2,600 degrees Cent., which is the limiting temperature of the magnesite lining. As there is no involuntary change in the current and no violent fluctuations take place, there is no strain placed on the prime mover. In other words, in this type of furnace, there is nothing to wear out but the lining, the furnace runs quietly and there are no carbon particles blowing through the air, owing to the method of melting the steel. The current being steady and the amount of steel in the furnace being known, the heat, with a little practice, can be accurately determined by observing the ammeter reading. The heat regulation of a Roechling-Rodenhauser furnace is absolutely under control. No foreign ingredients can inadvertently get into the metal bath, such as sulphur, phosphorus, carbon, nor any other substances from any flame, electrodes, or lining.

The heat is produced only by heavy induced current going directly through the bath, which allows superheating of the metal without the introduction of oxygen or nitrogen. The metal contains a minimum of gases. This reduces the amount of ferro-silicon and ferro-titanium required, if either of these alloys are used. Contrary to the gas heated or other furnaces or converters, the chemical composition and temperature can be regulated independently of each other. The composition of the metal can easily be changed and the temperature held at the desired point. The metal can be poured at the temperature to suit the conditions; for large castings into crane ladles, for small castings into crane ladles, for small castings, into bull ladles or small hand ladles. The furnace being of the tilting variety facilitates pouring, and the removal of the slag through the slag opening at the rear.

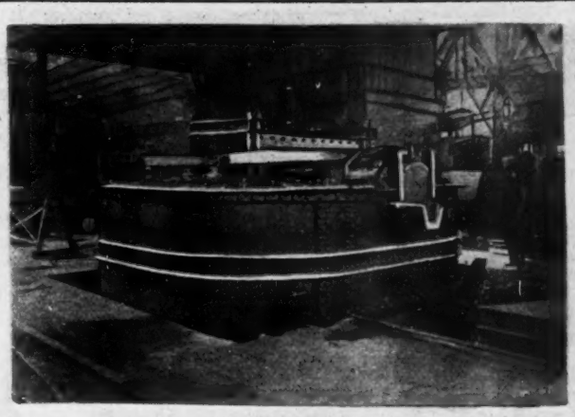


FIG. 1—FRONT VIEW OF ELECTRIC INDUCTION FURNACE OF 8 TONS CAPACITY

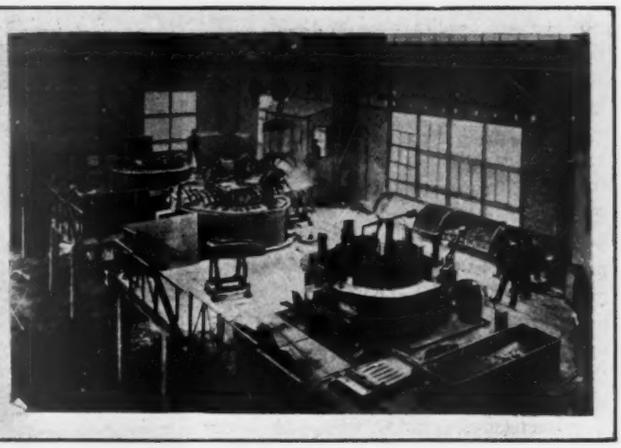


FIG. 2—BATTERY OF THREE 4-TON FURNACES; ONE IS BEING CHARGED FROM A MIXER

The items entering into the manufacture of steel castings are essentially as follows:

Raw Material.

(1) The raw material.
(2) The oxidation loss.

Conversion Cost.

(3) Electric current consumption and its cost per kilowatt-hour.
(4) Fluxes and additions.
(5) Labor.
(6) Tools, repairs and lining.
(7) Depreciation and interest.
(8) Auxiliary apparatus.

When charging cold material for making steel castings, the cheapest steel

*Presented at the Pittsburgh meeting of the American Foundrymen's Association.

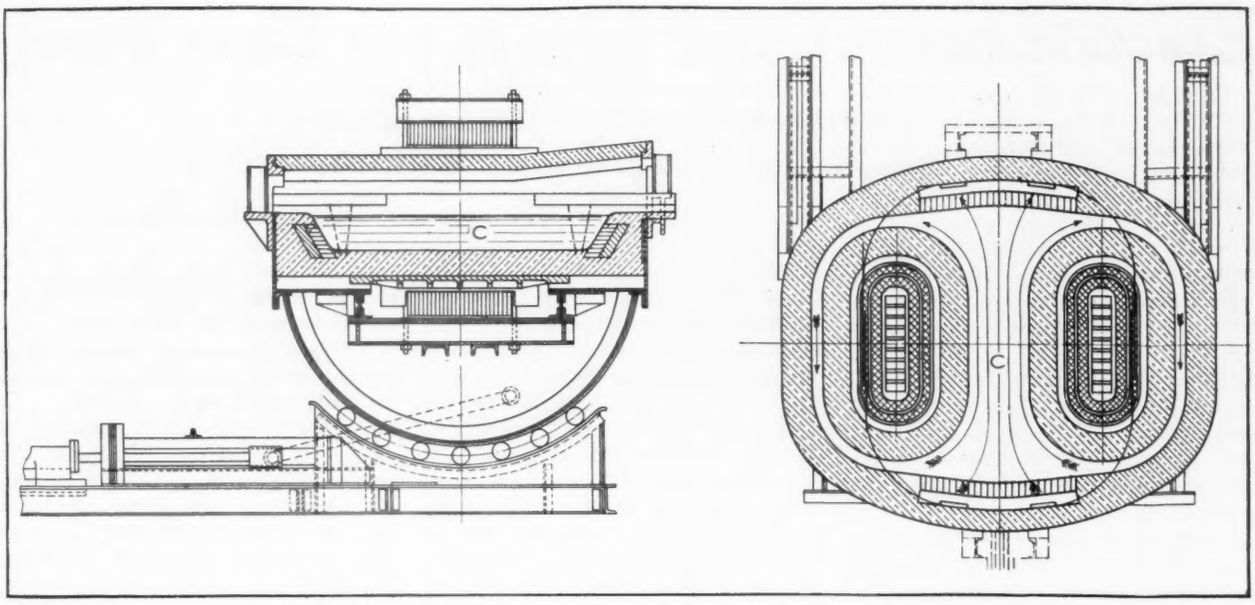


FIG. 3—CROSS-SECTION AND PLAN VIEW OF ELECTRIC FURNACE

scrap can be used to advantage and refined to the desired degree. The following makes a cheap and satisfactory mixture:

25 per cent bundled scrap at $11.25 per ton	$2.81
25 per cent machine shop and heavy turnings at $9.25 per ton	2.31
50 per cent old steel rails at $13.75	6.88
Total	$12.00
Oxidation loss, 5 per cent	.60
Total	$12.60

Electric current is being produced today for 0.6 cents per kilowatt-hour with internal combustion engines, running on blast furnace, producer, natural gas or crude oil. The electric induction furnace provides a high-load factor operating as it should at full load for the greater part of the day. This continued operation insures this low cost for electricity.

The conversion cost per ton using a 2-ton furnace with 280 to 300 kilowatts, is shown in Table I.

Charging Hot Metal

When charging hot metal for refining or merely for thorough deoxidation and segregation, it may be taken directly from the blast furnace, from a mixer, a cupola or some other furnace.

At Dommeldingen, Germany, pig iron was charged into an induction furnace of the Roechling-Rodenhauser type and refined as follows:

	Analysis of charge, per cent.	Analysis of cast, per cent.
Carbon	4.0	0.5
Phosphorus	1.8	0.025
Sulphur	0.2	0.03
Manganese	...	0.76
Silicon	1.0	0.056

Duration of conversion, 5 hours.

Such impure hot metal is rarely charged in the electric furnace, except under unusual conditions, as it can be partly refined by a gas-fired furnace cheaper than in an electric furnace.

The cost of refining hot metal taken from the mixer at Dommeldingen in a

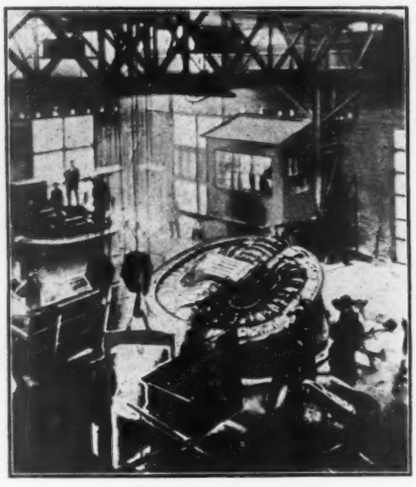


FIG. 4—TAPPING A 4-TON ELECTRIC FURNACE

5-ton furnace, allowing for American conditions, is as follows:

Raw material	$12.00
Oxidation loss 3 per cent	.36
	$12.36
Current, 280 kilowatt hours at 0.6c per kilowatt-hour	1.68
Fluxes, etc.	.60
Labor	.50
Tools, repairs and lining	.64
Depreciation 10 per cent, interest 5 per cent on $17,000, 300 days at 40 tons a day for 24 hours equals $2.550, 12,000 tons	.22
Auxiliary apparatus	.06
Total	$16.06
Cost of preliminary refining, about	3.00
Total cost of one ton of electric steel ready to pour	$19.06

Time of each heat about 2½ hours.

The estimated cost of refining hot metal melted in the cupola and consisting mainly of steel scrap, having about 2 per cent carbon in the resultant mixture is as follows:

Raw material	$14.00
Total oxidation loss 8 per cent	1.12
Total	$15.12
Conversion cost similar to the above	4.90
Cost of preliminary melt in cupola, about	3.00
Cost of one ton of electric steel ready to pour	$23.02

Time of each heat about 3½ hours.

Under ordinary conditions there is no very great difference in the total cost of hot metal ready to pour into the ladle, when charging either hot or cold material. The discrepancy is in the output. With a 5-ton furnace it is as follows:

	Per month. Single turn, tons.	Double turn, tons.
Cold charging	235	470
Hot charging	500	1,000

The electric current and all the machinery it entails, does not enter largely in the total cost of a casting. It is usually not over ¼ of a cent a pound or as little as 5 per cent or even 2 per cent of the selling cost of the finished product. Steel can be melted in the electric furnace for $4.20 in a 2-ton furnace and for about $3.50 in an 8-ton furnace with electricity at 0.6 cent per kilowatt-hour.

It takes longer to treat cold metal than hot and only three-fourths of the bath is tapped when cold metal is used instead of the entire contents of the furnace when hot metal is treated.

When charging cold metal, 25 per cent of the hot charge remains in the furnace to complete the electrical circuit. Cold scrap consisting of many pieces does not meet the required conditions, as the voltage in the bath is as

low as 2 or 3 volts, which is not sufficient to overcome the contact resistance between the numerous pieces of scrap.

Process of Making Steel

When operating the furnace, the limestone and roll scale are charged and the bath is refined until the analysis shows that no phosphorus remains, or the process may be stopped before this, thus retaining some phosphorus and cheapening the process. This refining usually lasts an hour or so, varying somewhat with the initial percentage of phosphorus present. During this dephosphorizing period the carbon is greatly reduced and the silicon is almost or entirely eliminated. This first slag is then thoroughly removed by tilting the furnace backwards at a slight angle and rabbling off the slag. Then, according whether mild or hard steel is required, a quantity of carbon is added to meet the requirements. At this time sufficient ferro-manganese is charged to meet the specifications. The desulphurizing slag is then added. As soon as this is melted, the bath and slag are deoxidized, the slag becomes white and owing to its increased temperature, absorbs the departing sulphur rapidly, the refining being dependent upon the temperature at the point of contact between the metal and the slag. The gases are expelled and likewise the small particles of slag which are expelled by deoxidation; in the same manner the sulphides are absorbed by the white lime slag, while a small part of the sulphides volatilizes; otherwise, the composition of the bath remains the same.

A carbon analysis is then obtained and the necessary modifications are made. In the case of alloy steels, the alloys are only added after the deoxidation period, so that any loss which might be caused through the formation of slags is avoided. This deoxidation period usually lasts an hour. It is this deoxidation period, so thorough and effective, which has no parallel in any gas-fired furnace or converter. The sulphur has meanwhile almost entirely disappeared, being reduced as low as 0.01 to 0.005 per cent. After a last analysis shows that the deoxidation of the metal is complete, the furnace is tapped without further additions. Castings weighing from ½ pound to the capacity of one or more furnaces are regularly made.

The chemical analyses and physical tests of annealed electric steel castings are given in Table II.

Table I.
CONVERSION COST

	Per long ton.
700 kilowatt hours for melting at 0.6 cent per kilowatt-hour	$4.20
200 kilowatt-hours for refining at 0.6 cent per kilowatt-hour	1.20
Total	$5.40
Fluxes, etc., roll scale 22 pounds, lime 77 pounds, fluorspar 11 pounds, sand 20 pounds, ferro-manganese 8.8 pounds	.44
Loss of fluxes owing to ¼ of all metal remaining in the hearth	.16
Labor, American equivalent, 2 to 3 men	1.50
Tools, repairs and lining	.67
Depreciation 10 per cent, interest 5 per cent on $11,300, 300 days, 6 tons a day of 12 hours equals $1,695, 1,800 tons equals	.94
Auxiliary apparatus (cooling air for transformer)	.04
Total	$9.15

TOTAL COST OF ELECTRIC STEEL

Raw material	$12.60
Conversion cost	9.15
Cost of 1 ton electric steel ready to pour	$21.75

To this cost must be added a slight license fee per ton depending on the output.
Time of heat about 4 to 4½ hours.

Table II.
CHEMICAL ANALYSES AND PHYSICAL TESTS OF ANNEALED ELECTRIC STEEL CASTINGS

Carbon, per cent.	Silicon, per cent.	Manganese, per cent.	Sulphur per cent.	Phosphorus, per cent.	Tensile strength, pounds, per square inch.	Elongation, per cent.
0.12	0.13	0.53	0.014	0.011	51,920	22.5
0.10	3.20	0.48	0.315	0.020	58,000	23.5
0.23	0.30	0.59	0.021	0.025	66,840	24.0
0.26	0.31	0.62	0.318	0.022	68,550	23.0
0.32	0.35	0.83	0.012	0.025	79,650	20.5
0.35	0.32	0.68	0.022	0.023	85,340	15.5
0.37	0.35	0.71	0.009	0.017	95,300	15.0

Annual Meeting of Institute of Metals

The annual meeting of the Institute of Metals will be held in London, Eng., Sept. 25 and 26, at the Institution of Electrical Engineers. Professional sessions will be held during the mornings of both days, while on Wednesday afternoon the members will be afforded an opportunity to visit the works of Fraser & Chalmers, Ltd., and the National physical laboratory. In the evening a reception will be tendered the visitors at the Royal United Service Institution. On Thursday an alternative excursion will be held, one being to Woolwich Arsenal by special steamer and the other being a visit to the Brooklands motor race course and aviation ground. Weather permitting, aeroplane competitions will take place for the Institute of Metals aviation prize.

Sly Sand Blast Installations

The W. W. Sly Mfg. Co., Cleveland, is erecting a 40 x 60-foot, two-story, steel and concrete addition to its plant, which will be devoted to the manufacture of sand blast equipment and dust arresters. Recently a contract was received for the installation of two steel sand blast rooms, including separators and dust arresters, in the foundry operated by the Bettendorf Axle Co., Bettendorf, Ia. This installation is a duplicate of one made by the Sly company several months ago. Three steel sand blast rooms with dust arresters, sand separators, etc., also are being installed in the plant of the Buckeye Steel Castings Co., Columbus, O. At the plant of the Gould Coupler Co., Depew, N. Y., an installation of four steel sand blast rooms will be made.

Utilizing Floor Space

In large foundries where the pressure of work is great, every effort is made to take advantage of each inch of available floor space. The Bethlehem Steel Co., South Bethlehem, Pa., maintains an unusual number of crane ladles of large capacity in its gray iron foundry. Instead of being placed on the foundry floor when not in use, they are kept suspended, by means of hooks, from the overhead crane runway, which extends down the center of the main bay of the foundry. Thus they are kept off the floor entirely when not in service. The Bethlehem Steel Co. employs another expedient in its foundry toward the same end. The trucks which are employed in the ovens in connection with the drying of molds and cores, are removed by the crane as soon as they are unloaded. Thus the space in front of the ovens may be used for molding.

Decorative Green Finishes

By Seymour W Rowsbar

THE ANCIENT Romans greatly prized a certain beautiful stone of a dark green color with patches of white and occasionally also, black and red. The stone is known as verde antique and is a specie of hard breccia. A breccia is a mass composed of angular fragments of rock of the same or different kinds cemented together by an enveloping paste or by infiltrated iron or carbonate of lime. This stone is still in great favor in Italy. Among the different green finishes upon the various articles displayed by the trade at the present time, but few approach the different beautiful shades nature has produced upon these stones. Many of the greens answer the purpose for which they are intended, but it does not require a trained eye to discern that they are but crude imitations of nature's coloring. Have you ever entered a store where these goods are sold and asked to be shown a lamp finished in green? Possibly so, and the dealer has shown you a sample, the finish resembling the surface of a thickly inhabited frog pond in tone, or perhaps not unlike the skin of an adder. The dealer informs you it is known as verde antique. Possibly you are a novice in the art of metal finishing and you endeavor to reproduce the finish, feeling satisfied you have the correct thing. Then what a cruel disappointment to later realize that you have yet to produce the real imitation. The verde antique finish should resemble as nearly as possible the surface of copper, brass or bronze which has been buried in the earth and subjected to certain corroding influences for an indefinite period. There are colorers and finishers who do not show any distinction between the verde antique finish and a green patina. According to Webster, verde antique is a term given to a green incrustation on ancient bronzes, brass and copper, while patina is latin for a pan or dish, but in the fine arts it designates a fine green rust with which ancient bronzes, copper coins and medals become covered by lying in particular soils, which, like varnish, are at once preservative and ornamental. Patina consists of carbonate or oxide of copper.

Producing an Artificial Patina

An artificial patina is produced by forgers of antiques by the use of acetic acid. The distinction between a green incrustation and a fine green rust is not closely drawn by this producer of antiques. From the standpoint of commercial significance it does not materially interest the plater, but if we desire to make the most of our profession from the standpoint of art it is of considerable importance that we become conversant with the modern interpretations of the two terms. Copper, brass and bronze articles which have been discovered by antiquarians are invariably coated with a green incrustation of almost a bluish shade and the surface is rough and uniformly corroded. Statues, busts, tablets or other bronzes which have been exposed to atmospheric influences for years have a semi-lustrous surface which at once commands the eye and is indeed a study. The fine green rust is comparatively smooth and does not have the appearance of being incrusted, but rather appears to be upon the surface. The aeroform fluid surrounding the earth is made up of various gases comprising varying quantities of oxygen, nitrous acid, carbonic acid, ammonia, hydrogen, etc., according to the locality and season of the year. The atmospheric influence upon the surface of metals exposed is proportionate to the quantity of some one or more gases prevailing; thus the oxidation may be rapid or slow and the shades will vary in beauty in proportion to the time these agents have been at work.

To imitate these green shades by corrosive solutions, something more than the decorative skill of the finisher is required. To be able to produce the commercial finishes of green should not suffice. The plater should allow the artistic capabilities within him to enlarge and in doing so the profession as a whole will be benefitted. First select the formula and thoroughly acquaint yourself with its composition, taking each chemical separately. If satisfied it should produce the desired results, try it out, but bear in mind a proper knowledge and proper manipulation of the corroding solution affects your success more than the formula. As in other branches of metal finishing, the simple formula often yields best results. Perhaps you endeavor to finish a dome and chain, such as a dining room electric light fixture, but are unable to produce the same shade of green upon the chain which you get upon the dome. If so, stop and consider the possible difference in the two surfaces and the influences to which each has been subjected. If then you are unable to solve the difficulty, try moistening clean fresh leather meal with the following solution and bury the articles in the meal: Muriatic acid, 2 ounces; acetic acid, 4 ounces, and sal-ammoniac, 5 ounces, to which add 5 quarts of water. Allow the articles to remain buried for from 36 to 48 hours with the surrounding atmosphere the usual temperature of the plating room. When removed from the meal shake off the adhering meal as much as possible and pass quickly through clean, cold water and allow to dry without heat, after which lightly dust

off the remaining particles of meal and proceed to lacquer.

For the imitation patina by this method, use copper sulphate, 5 ounces; sal-ammoniac, 10 ounces, and one gallon of water. After removing the meal, pass through water and dry as stated. When dry, brush over the surface with a very soft brush to which a paste of turpentine and beeswax or beeswax alone has been applied sparingly. The surface of the articles should be clean in all cases.

To produce a smooth shading of light and dark green, sometimes refired to an egg-shell finish or Tiffany green, use crystallized chloride of iron, 3 ounces; sal-ammoniac, 1 pound; verdigris, 8 ounces; common salt, 10 ounces; potassium bitartrate, 4 ounces, and one gallon of water. Mix thoroughly and immerse the articles, or if the articles are large, apply a brush. When nearly dry, stipple the surface with a soft round brush and slightly wet with the solution. In this manner the variegated appearance is produced. Owing to the varying strength of the chemicals, the immersion or first application may not suffice in all cases. The application then should be repeated before stippling. When stippled, apply a coat of lacquer and wax with a soft brush and beeswax only. Some prefer to dispense with the lacquer and simply wax the surface when perfectly dry. The character of the article and its subsequent disposal should decide this point.

Pigment Process

The combination of the pigment method and a green patina surface proves very pleasing, particularly when the work of a really artistic finisher approaches the appearance of the genuine verde antique or such as produced by the corrosion method. The pigments such as zinc white, lamp black, chrome, green chrome, yellow, paris green, malachite green, etc., are easily obtained and are inexpensive. The application of pigments, however, necessitates the exercise of skill and artistic taste possessed by comparatively few men in the business. The one advantage of the pigment process is the fact that it does not require an unusually heavy deposit of copper as a base. The articles are sand-blasted to obtain the best results, or when the copper deposit is of sufficient thickness to allow it, the article may be roughened by dipping it in a solution of nitric acid, 1 gallon, and oil of vitrol, 1 gallon, after first cleaning the surface. Where the green surface is produced commercially, it is often advisable to hasten the operation by the use of a moisture producing box or kiln equipped with a steam pipe and receptacles for water which aid in keeping the air moist during the corrosion period. Glycerine or chloride of zinc also is used as an addition to some solutions to retard the drying. Too much of either renders the surface difficult to dry or to successfully lacquer.

Green Finish by Electro-Plating

The green finish may also be obtained by the aid of the electric current and when required on articles of soft metal, this process has many advantages. For many years soft metals could only be given the green finishes by the pigment process but by using the electric current it may now be produced directly upon the soft metal surface. The solutions used for this process are all very similar, the essential differences being merely slight modifications which are supposed to render the process more rapid. For this method use bichromate of potash (KO, 2 Cr O_3), 12 ounces; sulphate of copper, 4 ounces, and water, 1 gallon. Pulverize the chemicals and dissolve in the previously heated water; then allow the solution to cool. The articles treated are connected as the cathode while narrow strips of copper are used for anodes. These should be plentiful in number and should entirely surround the work. The distance between articles and anodes should be at least 5 or 6 inches and a current pressure of from 5 to 7 volts is required for best results and a reasonably rapid treatment. As the color is not produced uniformly in the solution, the operator will probably require a few trials to determine the proper stage at which to remove the articles. When removed from the solution, the articles are allowed to remain in the air for 10 or 15 minutes without rinsing. This brings out the beautiful shades. The articles are then rinsed in cold water, followed by immersion in hot water and then are allowed to dry. By going over the dried surface with a soft brush the effect is greatly improved. Lacquer may now be applied or the surface waxed, or it may be left unprotected if not to be subjected to friction, as it is very durable. The very low cost of this method especially adapts it to certain lines of work upon which the production of antique finishes have heretofore been impracticable on account of the cost.

In the production of verde finishes by other than the electric process it would be well to remember that when producing light greens, the finish is applied directly upon the cleaned copper or brass surface. When a dark green is desired, it is customary to darken the surface by oxidizing with liver of sulphur, carbonate of copper and ammonia or similar means. It also has been found that the rougher the surface the more ancient is the effect. If the first immersion in a solution does not produce the proper shade and a denser, deeper tone is desired, repeat the operation and allow the object to dry. Three or four immersions may be necessary with some solutions upon certain classes of work. For portions to be left in relief use dry pumice stone. While corroding, a warm, moist atmosphere is absolutely essential for the best results.

Cleaning Nickel Solutions

By J. H. Hansjosten

In the July issue of THE FOUNDRY, page 276, an inquiry and answer was published relative to cleaning nickel solutions. The inquirer states that the work becomes almost black and is practically without a deposit. In the answer it is asserted that the solution has been deficient in metal salts and is also alkaline. Both may be right, but it is surely the former. However, I doubt very much that the solution has become alkaline, in fact, I believe the opposite is the case and the solution is very much acid. The addition of 5 ounces of sulphuric acid to 100 gallons of solution would only increase the difficulties. Before attempting to remedy an abnormal condition of a nickel solution, or any plating solution for that matter, the plater should first ascertain the cause of his trouble and then should apply the remedy.

My suggestion for overcoming this difficulty follows: If the distance between the anode and cathode is small, for instance less than 5 inches, the current should be reduced to two volts. This will reduce the tendency of the work to burn or to turn black at the edges. The greater the distance between the anode and cathode the more resistance will be offered to the current and a higher current may be employed. If this does not overcome the difficulties referred to the litmus paper test should be applied. This will show directly whether the solution is acid or alkaline. If the solution is alkaline, first add double nickel salts, but no acid. If the

addition of double salts too greatly increases the density of the solution, a sufficient amount of solution can be taken out of the tank and water should be added until the remainder of the solution is reduced to 5½ degrees on a Beaume hydrometer. Double salts should then be added until the solution registers 6½ degrees. The litmus paper test should then be applied and it will be found that the solution is nearly neutral. The addition of acid, particularly by a plater who has had little experience, is dangerous, and more solutions are ruined by this than any other way. The cure-all for sick nickel solutions, with many platers not thoroughly grounded in their work, seems to consist of additions of acid, and for copper and brass, the addition of cyanide. Both are necessary ingredients of the solution to which they belong, but both may be used to excess.

If the litmus test shows the solution is acid, carbonate of nickel should be added until the solution is neutral. If this too greatly increases the density of the solution the plater should proceed as previously outlined and should remove some of the solution from the plating tank into a barrel for future use. The tank should then be filled with water.

TROUBLES OF THE ELECTRO-PLATER

Discussed by Practical Men

Electro-Galvanizing Solution

Will you kindly publish a formula for galvanizing by electricity? We would like a method we could use in our plating room on small goods.

A very good electro-galvanizing solution consists of the following: Sulphate of zinc, 2 pounds; sulphate of aluminum, 4 ounces; black molasses, ¼ ounce, and water, 1 gallon. Dissolve the sulphates in boiling water and add the molasses, after which stir well. Place the anodes, which should consist of 98 per cent spelter and 2 per cent aluminum, in the solution and allow to remain over night before using. By so doing the addition of neutralizing salts is avoided. From 5 to 6 volts tension should be used to obtain satisfactory results.

Phosphate of Gold Solution

We would like a formula for phosphate of gold solution, together with a formula for removing the pickle coating from gold to restore the original color.

The phosphate of gold solution is made as follows: Phosphate of soda, 8 ounces; sulphite of soda, 1½ ounces; C. P. potassium cyanide, 3 ounces; neutral chloride of gold, 7 pennyweights and water, 1 gallon. Use 24 carat gold anode and the solution at about 150 to 180 degrees Fahr. To remove the pickle coating proceed to prepare the following solution: Liquid ammonia, 4 ounces; carbonate of soda, 4 ounces; carbonate of copper, 2 ounces, and water, 1 gallon. Dissolve the carbonates in the ammonia and add the water, then increase the density of the mixture to 16 degrees Baume. Place the negative wire around the circumference of the crock containing the solution and attach to it sheets of copper and bring the positive wire across the center of the crock. The work hung on the positive wire and immersed in the solution a few seconds will be freed from the pickle stain. The slight accumulation of gold in the solution may be recovered by evaporation.

Solution for Silver Etching

I would be pleased to receive some information regarding the kind of acid which should be used on silver for etching purposes.

For etching without the electric current a mixture of equal parts of nitric acid and water is used as the etching fluid. The articles are painted with the usual stopping-off varnish and the parts to be etched are then processed. Silver may be etched very rapidly by using an electro etching solution consisting of 5 or 10 per cent of pure nitric acid in water. The cathode used with this solution should consist of pure sheet aluminum and the articles to be etched are connected as the anodes. By either method nitrate of silver is formed and may be recovered or used in connection with the plating solutions if desired.

How to Detect Arsenic

Will you advise me of some simple test to detect arsenic in muriatic and sulphuric acids?

Dilute a quantity of the acid, either muriatic or sulphuric, and pass in sulphuretted hydrogen. If a yellow precipitate is obtained it indicates the presence of arsenic. It may be that iron is the impurity which causes the difficulty. If so it may be detected by diluting the acid and adding potassium thiocyanate. If iron is present it will produce a red color.

Japanese Bronze Finish

We have a sample of what we understand is japanese bronze finish, but have not been able to match it. Can you advise us how to proceed?

Polish and clean the articles and run in a cyanide copper bath for about 20 to 30 minutes. A shorter period will suffice on plain pieces. Rinse well in running water and place the articles for a moment, or until the dark color appears, in the following solution: One ounce of sulphurette of potassium; ¼ ounce of sulphate of ammonia, and 4 gallons of water. After removing the objects, rinse well in cold water, then in hot water and dry in hard-wood saw dust. The solution is used cold. By dry brushing with a soft, fine, brass wire brush the color may be improved. Lacquer with transparent lacquer.

Gun Metal Finish

How is the gun metal finish on carpenters' and machinists' tools produced?

Use a solution of alcohol, 4 ounces; ferric chloride, ¾ ounces; water, 6 ounces. This should be kept air tight when not in use. Polish and clean the articles, pass through hot water and dry without staining, then apply the solution with a sponge. A surplus of solution in the sponge causes the corrosion to take place unevenly. The article is then hung in a warm, moist atmosphere for 45 minutes or an hour. A steam kiln is required. When removed, the work is allowed to dry in the air or is placed in clean, boiling water for 10 or 15 minutes. When dry, it is scratch-brushed with a soft, circular, iron-wire brush. Two to three operations are sometimes necessary on malleable iron, while steel corrodes more readily. When finished, apply linseed oil and dry.

THE BRASS FOUNDRY

A Discussion of Modern Brassfounding*

By H S Primrose

IN MODERN brass founding the chief considerations to be kept in view are economic working and scientific control. The former is largely brought about by the adoption of various labor-saving devices, which reduce most of the operations to mechanical repetition, and a systematic layout of the plant which allows of the metal passing through the various stages of treatment in a straightforward direction. The control of the metal must be complete, beginning with the raw material and tracing it through all departments until it is sent out as a finished product. This scientific control should deal not only with the chemical composition but also with the physical tests, and, wherever possible, with the micro-structure in addition.

It must be stated at the outset, in order that the term *brass-founding* may not be misunderstood, that the principles and practice detailed in this paper deal first of all with what is really a bronze, technically known as admiralty gun metal, and containing 88 per cent copper, 10 per cent tin and 2 per cent zinc, according to specification. The details of working are, of course, equally applicable, with the necessary modifications, to the founding of true brass containing only copper and zinc.

A view of one bay of the brass foundry operated by G. & J. Weir, Ltd., Cathcart, Eng., is shown in Fig. 1. It will be noted that the roof is of sufficent height to insure ample ventilation and it is provided, almost over its entire surface, with skylights, which afford an abundance of light. This bay is devoted to the molding and pouring of heavy brass castings.

The important point to be considered in designing a brass foundry is the provision of ample light and ventilation, and this is best accomplished by having high roofs copiously glazed, and provided with numerous openings through which the fumes and gases can escape readily. Poor ventilation in brass foundries is highly injurious to the health of the workmen and the employer who is interested in the welfare of his employes will give the subject of ventilation careful consideration, and also install good sanitary arrangements. In many of the most up-to-date foundries all the employes are provided with lockers, and a sufficient number of wash-basins are provided for their use. The expense of these arrangements quickly repays itself by the increased efficiency of the operations performed under healthful conditions.

FIG. 1—A VIEW OF ONE BAY OF THE BRASS FOUNDRY OPERATED BY G. & J. WEIR, LTD., CATHCART, ENG.

The type of furnaces to be used will depend upon the class of metal employed and the size of the castings to be made. For small gun metal work the ordinary coke-burning crucible furnace is suitable where the output is not large, but for larger work it is advisable to have a reverberatory furnace of convenient size. The pot-fires are best arranged in a battery placed at floor level, in front of which are the ash-pits covered by a grating on which the melters can stand, and behind the fires the individual flues run into the main flue connected with the stack. The drying stoves and cleaning shop are also within short range of the furnaces, and opposite them may be situated a large heating furnace for dealing with large scrap which requires to be

*Presented at the Cardiff convention of the British Foundrymen's Association.

FIG. 2—BATTERY OF 17 COKE-FIRED FURNACES

FIG. 3—AIR FURNACES FOR MELTING BRASS

FIG. 4—THE MOLDING MACHINE FLOOR

FIG. 5—DOUBLE CHAMBER DRYING STOVE

FIG. 6—CORNER OF THE CLEANING SHOP

FIG. 7—SAND BLAST ROOMS

FIG. 8—PAN MILLS FOR RECOVERING METAL FROM ASHES

FIG. 9—MAGNETIC SEPARATORS FOR CLEANING BORINGS

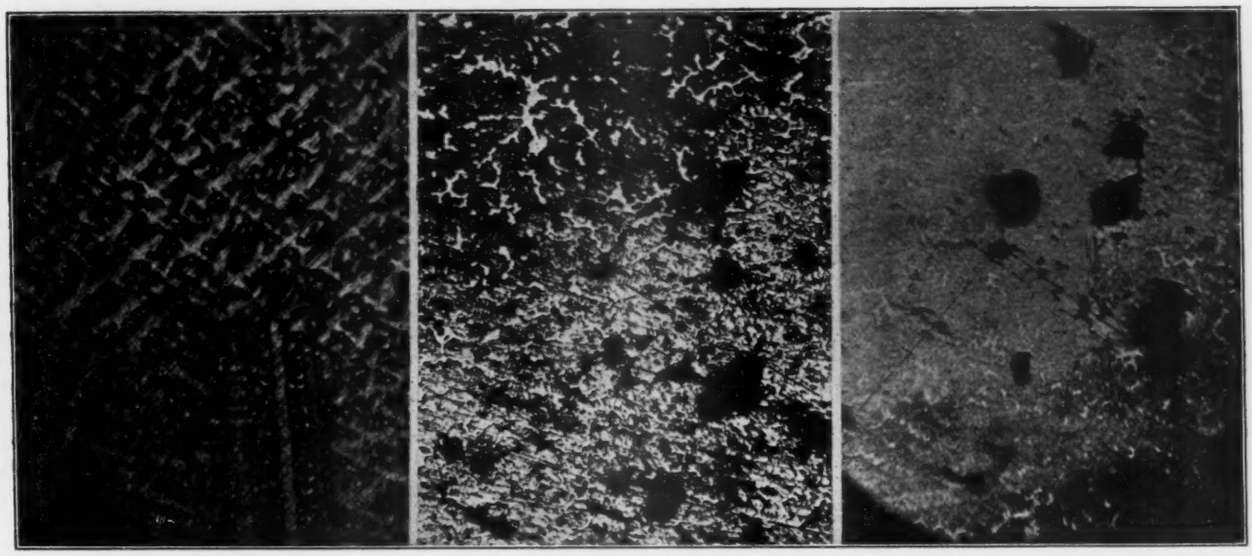


FIG. 10—MICRO-STRUCTURE OF GOOD GUN METAL
(Magnification, 30 diameters.)

FIG. 11—MICRO-STRUCTURE OF GOOD GUN METAL, SHOWING DEEP-SEATED GAS HOLES
(Magnification, 60 diameters.)

FIG. 12—MICRO-STRUCTURE OF GOOD GUN METAL, SHOWING STEAM HOLES NEAR SURFACE
(Magnification, 30 diameters.)

broken before charging into the air furnaces.

A battery of 17 coke-fired furnaces is illustrated in Fig. 2. Each hole has a capacity for crucibles holding 240 pounds of metal. These furnaces are located contiguous to the metal storage, molding floor and cleaning department. The air furnaces for melting brass are shown in Fig. 3. Their capacities are 5 and 7½ tons, respectively, and are fired with splint coal.

Molding Shop

Molding machines are now almost universally used for small duplicate work. For heavier work plate-molding is now very general, the pattern being made in several parts which can be attached to the plates. The flasks are lowered over these, rammed, finished and thoroughly dried in the stoves. The various parts of the mold are collected, the cores put in and fixed, the job closed and bolted together and then cast on end. In the background of Fig. 4 are several stripping-plate molding machines and the pouring floor is in the foreground.

For cleaning the molds, compressed air is highly advantageous, and should, wherever possible, be led to every part of the foundry; it is certainly much more efficacious than the old-fashioned bellows. The stove accommodation for drying large and small molds must be very extensive.

Fig. 5 shows a good type of a double stove which is fired from the side. Smaller stoves also must be provided for drying cores. These may be fired by gas or coke.

While, as a general rule, it is advisable to carry out the casting of large work in dry-sand molds, it is permissible to execute most of the small work in green sand. For facings, it is customary to use good blacking in the dry sand molds, but more often the green sand work is dusted with plumbago. Large barrel cores are made up of loam and straw, and for small, intricate cores a mixture of finer sand with molasses and flour gives good results, being strongly binding, porous, and easily removed.

Each main bay should be served with

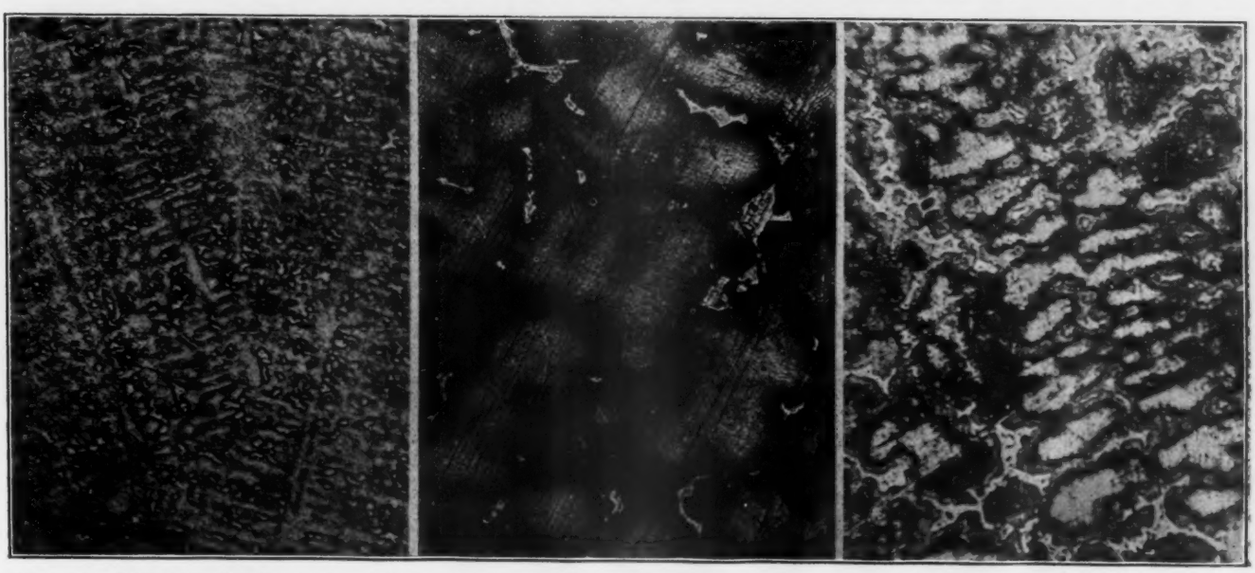


FIG. 13—MICRO-STRUCTURE OF GOOD GUN METAL, SAME AS FIG. 12 REMELTED
(Magnification, 60 diameters.)

FIG. 14—MICRO-STRUCTURE OF GOOD GUN METAL, SHOWING ISOLATED EUTECTIC AREAS
(Magnification, 240 diameters.)

FIG. 15—MICRO-STRUCTURE OF GUN METAL, SHOWING BRITTLE EUTECTIC AREAS
(Magnification, 240 diameters.)

at least one overhead electric crane, capable of rapidly lifting and transporting the heaviest molds to be dealt with, and they can also be made to handle the large ladles used for heavy casts. Side bays can be fitted with small, overhead hand cranes, as well as hydraulic cranes to operate smaller work and to aid in the lifting-out operation at the pot fires.

For transporting metal, small molds and finished castings, a narrow-gage tramway should be led throughout the shops, and the cars run on this may be made to serve other useful purposes. For cutting, riddling and mixing sand, electric appliances are largely in vogue, and possess special advantages in dealing with large quantities.

Practice

In working the crucible furnaces, it is convenient to have the charges carefully weighed and stacked at each fire ready for charging and melting. By suitably arranging the draft so as to get as complete combustion of the coke as possible, a good melter is able to take off at least four 160-pound heats from each of nine furnaces in a working day of 9¾ hours, and those working with 240-pound pots should be able to get out at least three melts from each of eight furnaces in the same time.

There are three important points to be taken into account in good melting practice: (1) The length of time the metal is in the furnace; (2) the character of the covering or flux; and (3) the temperature of melting and casting. The time of a melt depends chiefly on the weight of the charge, and with a bright fire it should be kept as short as possible consistent with the complete fusion and mixing of the constituents, as prolonged *stewing* only tends to increased absorption of gas, which causes blow-holes when the metal solidifies. One of the best coverings for rich copper alloys is ground glass, which possesses the advantages of simplicity and cheapness. When the pots are drawn and carefully skimmed, they are covered with a circular iron lid with a small pouring opening, and this saves most of the objectionable zinc fumes which would otherwise be given off copiously. The fuel used in melting is about 44 per cent of the weight of metal.

Air Furnaces

The proportions of the charges for these furnaces are weighed out according to the composition of the alloy required, and the material is collected on the charging platform. The greater part of the charge being made up on the inclined bed of the furnace, the fire is started in the forenoon, and charging is completed by noon. With a 7-ton charge the metal is ready for tapping at about five o'clock in the afternoon, when the requisite tin is added and after thorough rabbling and reheating, the charge is ready for tapping in another half-hour. It is found advisable not to draw all the metal off at one time, but to split the tap up into three lots of about 50 cwts. each, rabbling between each to minimize segregation. Prior to casting, the metal in the ladles should be carefully skimmed and covered with a layer of charcoal. The fuel consumption amounts to about 20 per cent of the weight of the charge.

Table I.

Example of a 7-Ton Air-Furnace Charge Sheet. Charge of No. 1 Admiralty Gun Metal.

Material.	Charge—Weight, cwts.	Per cent.	Copper. Cwts.	Per cent.	Tin. Cwts. per cent.	Per cent.	Zinc. Cwts. per cent.	Per cent.	Lead. Cwts. per cent.	Per cent.
Shop scrap	20	87.8	1,756	9.5	180	2.0	40	0.7	14	
Bought-in scrap	59	85.5	5,044	8.5	501	5.0	295	1.0	59	
Machine borings	20	87.7	1,754	9.5	180	2.0	40	0.8	16	
Copper ingots	36	100.0	3,600	...	...	...	..	...	..	
Tin ingots	5	....	.....	100.0	500	...	..	...	..	
Total	140	....	12.154	...	1,361	...	375	...	89	
Average (calculated analysis)	...	87.0	.....	9.7	...	2.7	..	0.63	..	
(Actual analysis)	..	87.9	.....	9.5	...	2.0	..	0.60	..	

Physical Tests.

	Diameter.	Tensile strength.	Elongation on 2 inch	Per cent.
Bar No. 1	51-64 inch	16.2 tons per square inch	0.48 inch	24.0
Bar No. 2	51-64 inch	16.2 tons per square inch	0.44 inch	22.0

Cleaning Shop

After the castings have been shaken-out of the flasks, they are then immediately run into the cleaning shop, which should be placed as near to the casting floor as possible. In addition to the ordinary hand tools, very useful fittings are heavy sprue cutters, band saws, pneumatic chipping hammers and grinders. For an easy method of removing cores, and also for imparting a splendid finish to the castings, a sand-blast plant is almost a necessity. This plant has many advantages, and for large outputs has almost completely replaced hand cleaning.

The large scrap from the cleaning shop is generally clean, and consists of runners and fins from the castings, the pouring heads having been dealt with previously on the casting floor. This scrap can be sent back direct to the metal store and used over again in making up the furnace charges.

It is an important economical consideration to systematically collect all the pot-fire ashes, crucible furnace and ladle skimmings, as well as the dust from the cleaning shop. Riddling recovers the larger pieces of metal, but it is advisable, especially with the furnace ashes, to crush these with water in a special form of inclined pan mill with heavy grinding balls. The metal is left in nodules in the pans, whilst the finely-powdered ashes and small metallic particles are washed over and collected in a settler for subsequent sale.

In cases where an engineering shop is connected with the foundry, it is highly advisable to keep the borings and turnings as clear as possible of iron and steel, and further, to insure complete removal of any chance contaminations by passing the metal through a suitable form of electro-magnetic separator.

Chemical Analysis

For the accurate control of a brass foundry it is essential to have a well-equipped metallurgical and testing department, especially when the products have to conform closely to specification. Accurate knowledge of the allowances to be made in melting must be ascertained, and the amount of oxidation and volatilization losses under the particular conditions of working must be determined in order to maintain a uniform composition of the resulting alloy. All scrap metal bought should be melted, cast into ingots, and stacked in lots according to its analyses. The best results are only obtainable by making up the proportions of the charge constituents from the laboratory analysis, and in order to keep a thorough check on the resulting melts it is advisable to have these analyzed also. All raw material, such as copper, tin, zinc, scrap, etc., should be bought to analysis, and carefully checked on delivery to insure that it conforms to the specification. Where it is not possible to purchase on this basis, the material ought to be carefully analyzed, and mixed accordingly.

The cost price of an alloy is largely determined by the price of the compo-

nent parts, and when these differ considerably in value, even a slight variation in the alloy composition increases its cost. With copper at 6d per pound and tin at 1s 8d per pound, a true gun metal of 90/10 composition would work out at 61s 8d per 100 pounds, but if, by mixing anything other than pure metals without knowing the analysis the tin content is increased to 11 per cent, then the resulting alloy would cost 62s 10d per 100 pounds. Such a variation may quite easily occur in practice which is not controlled by chemical analysis, and for a melt of 20 tons per week the loss would amount to £26, which is equivalent to £1,350 per annum. It is evident that in this and similar cases the cost of chemical control soon pays for itself several times over.

Another fruitful source of loss in a brass foundry is the copper carried by the refuse of various kinds, such as ashes, skimmings, floor sweepings, broken crucibles, etc. It is not always possible to erect a plant in a foundry to recover the metallic portion of this waste, but it is certainly advantageous to dispose of it according to the copper content as determined by sampling and chemical analysis, and thus obtain a proper value for the material.

Physical Testing

The most important physical testing to be done is with the cast metal in order to ascertain if it is up to the standard required, and sometimes this is able to detect material which, although correct in chemical composition, is faulty in structure and therefore unsuited for service. When such tests show low results, the fracture may reveal a possible source of the trouble, but in many cases it does not, and then it is necessary to adopt some other method of investigation.

In addition to the physical tests of the alloys, it pays to make examination of the various refractory materials, such as fire bricks and fire clay, used in the furnaces. Also the various molding and core sands should be tested, besides by analysis, for fineness, binding qualities, refractory properties, and porosity. Crucibles are an important item of expense, and every batch ought to be tested for strength and durability. The plumbago and blacking used for facings often cause trouble in practice unless carefully tested for impurities as well as volatile matter, ash and carbon content. It is important to keep a check upon the heating power of the fuel used, and the coke used must be low in sulphur and ash, and not subject to clinkering.

Within the last few years great progress has been made in the examination of the micro-structure of alloys, and this science of metallography is becoming a most valuable aid to the foundry metallurgist. It is rapidly replacing the older method of judging by fracture, and is, without doubt, a more certain guide to the foundryman who wishes to escape the repetition of serious failures due to causes other than change of chemical composition.

The temperature of melting and pouring has a great influence on the strength of gun metal castings. The chief cause for the variations which occur in the quality of the metal is the different rates of cooling through the molten condition and complete solidification. By pouring at a suitably high temperature, which depends upon the work in hand, the sand of the mold becomes highly heated, so that the freezing of the metal is slower than if the metal is cast dull, and hence the crystals have time to grow into a good strong interlocking structure.

This formation is clearly shown in Fig. 10, which is the photo-micrograph of an admiralty gun metal test bar from a casting poured at a temperature of 1,100 degrees Cent., and cooled slowly. The tensile strength of this bar was 16 tons per square inch with a 24 per cent elongation in 2 inches.

Table II.

Condition of metal.—Clean and hot, cast about 1,100 degrees Cent. Three taps, each about 50 cwts.
Time of melting.—Charged, 10 a. m. to 12 noon; tapped, 4:30 p. m.—6½ hours.
Fuel consumption.—30 cwts. (Splint coal).

Specification of Admiralty Gun Metal.

Composition.—Tin, 10 per cent; zinc (max.), 2 per cent; copper, remainder; impurities, nil. All copper is to be of approved quality. A deviation of more than 1 per cent in the specified composition is sufficient to condemn the material.
Tensile tests.—The test pieces taken from the casting have to stand the following tests:—Ultimate strength, not less than 14 tons per square inch; elongation on 2 inch, not less than 7.5 per cent.
General.—The castings are to be sound, clean and free from blow-holes.

Blow-holes

Blow-holes are often troublesome in gun metal castings and very materially reduce the strength. They may be due to a variety of causes, among which are dampness in the mold, gases either entrapped in the mold or dissolved in the metal, and metallic oxides partly dissolved or mechanically mixed with the metal. They are often so small as to escape detection unless under the microscope, and this examination most clearly reveals their distribution and the most probable source of the trouble. When this is known, the remedy is easily found. Fig. 11 shows one type of blow-hole deep seated in the metal, evidently due to gas inclusions which leave the cavities quite clean but so destroy the continuity of the structure that the interlocking of the crystals is diminished and the tensile strength is much lowered, even though, as in this case, the chemical composition be right and the metal properly cast.

When the blow-holes are sharply defined but confined to the outer portions of the casting, they are more likely to be due to steam generated within the mold, and this produces a local chilling which completely alters the structure, as shown in Fig. 12. This is the micro-structure of a casting of perfectly satisfactory gun metal by analysis, but which in this condition only stood a tensile strain of 5 tons per square inch. A simple remelting was sufficient to bring this metal right, and Fig. 13 shows the improved structure brought about in this way. The tensile strength was increased to 16 tons per square inch.

Use of the Pyrometer

The pyrometer is of great service in determining the temperature of the metal before pouring, but it is not practicable to observe the rate of cooling of each casting and to attempt to regulate it. As gun metal cools from fusion it passes through three distinct stages before it reaches normal temperature. In the first place a solid solution of copper with a little tin in it separates out, and this is known as alpha (*a*) constituent, which is soft and ductile. As further cooling takes place the remainder of the metal solidifies as a second constituent which is a solid solution of copper containing a larger amount of tin, and this is known as the beta (*b*) constituent. The alloy is now completely solid and consists of primary crystallites of alpha and areas of beta in the interstices. The beta constituent, however, is not stable, and as the temperature falls to about 500 degrees Cent. it breaks up into a mixture of alpha constituent, and delta constituent, which is a compound of copper and tin, having the formula Cu_4Sn. This is rich in tin (about 33 per cent) and corresponds very closely to speculum metal, which accounts for its hard, brittle nature. The alloy is stable at an ordinary temperature and consists of a mixture of primary alpha

crystallites, in which is embedded the hard delta constituent which forms a eutectic structure with the secondary alpha, and remains white on etching. Such a normal structure obtained by slowly cooling a gun metal casting is shown in Fig. 14, and illustrates the uniform distribution of the white eutectic areas, completely surrounded by the soft alpha constituent. A test bar cut from this metal stood 16 tons tensile strength, and showed an elongation of 24 per cent in 2 inches. For comparison, Fig. 15, is reproduced to show how improper cooling can diminish the primary crystallites of alpha constituent, and cause it to be almost surrounded by the white eutectic areas. The physical tests of this material show little diminution in the tensile strength, but the elongation was very adversely affected, being only 9 per cent in 2 inches.

The enormous value of the microscopical examination must be clear from even these few examples, and in the last-quoted case it suggests that a remedy for the low elongation results could be found by a suitable annealing of the metal above the temperature of 500 degrees Cent. in order to promote the growth of the primary alpha-crystallites and the absorption or balling-up of the eutectic areas into a uniform and less harmful distribution. In fact, the more completely these eutectiferous areas can be removed, the better the alloy becomes, and without doubt the correct solution of most of the common corrosion troubles lies in the direction of completely eliminating the eutectic.

BRASS FOUNDRY DIFFICULTIES

Solved by Experts

Cadmium in Aluminum Castings

Some aluminum castings that we are occasionally called upon to make are of such an intricate shape that they crack very readily and we have been advised to add a small percentage of cadmium to the alloy in order to correct this difficulty. We find, however, that the use of this metal will increase the cost of the castings to such an extent that the profit will be absorbed; we are willing, for other reasons, to use the cadmium, but we doubt whether it will be of any benefit and would like to have an expression of your opinion on the subject.

We fail to see how the addition of cadmium will prevent the cracking of the castings; it is very similar to zinc and has about the same effect. We do not advise its use, but would suggest that you try the following alloy: Copper, 7 pounds, and aluminum, 92 pounds.

Aluminum Bronze Bushings

Recently we received an order for a number of bushings to be cast of aluminum bronze for which we would like a suitable formula with a few particulars regarding the manner in which they should be molded and cast. These bushings are 18 inches long, 9 and 1/4 inches outside and 7 and 3/4 inches inside diameter, the metal thickness being 3/4 inch. Some time ago when making brass bushings we experienced considerable trouble, on account of porosity, but we ultimately found that if the metal is properly melted and poured at a medium temperature porosity is eliminated, and we are of the opinion the same applies to aluminum bronze.

While the manner in which aluminum bronze is handled in the furnace and the temperature at which it may be poured exercise an important influence in the founding of this metal, there are other considerations that affect the quality of the castings which are more difficult to control. The most important of these is the great affinity of aluminum for oxygen, which causes it to oxidize so rapidly while molten, that it is the most difficult metal to cast that the brass founder has ever encountered. The least agitation of the metal while molten causes the oxide to form, consequently dross is formed by the striking of the metal at the bottom of the sprue and by its friction against the sides of the runner and the mold. Bottom gates are usually employed on the theory that these introduce the metal into the mold with the least agitation, but in the case of heavy gears, drop gating has been found to produce the soundest castings, in conjunction with the use of a hopper head on top of the mold into which all the metal required for the casting is poured. By releasing a plug in the bottom of the hopper the metal is dropped direct into the mold. We would suggest in this case, that the bushings be cast on end. They should be gated at the bottom with a horn gate, the metal being poured as quietly as possible, that is, steadily and without striking the sides of the runner. A heavy riser should be taken off the top of the mold and if this does not give good results try the drop gating method.

Your difficulty will be found to consist entirely in obtaining castings free from dross, and if you fail to accomplish this we suggest that you induce the customer to accept manganese bronze in place of aluminum bronze.

Melting Bronze in the Electric Furnace

Is the electric furnace being used to any extent for melting brass and bronze, and if so, is the arc or induction type best adapted for this purpose?

The electric furnace, thus far, has not been applied extensively to the melting of copper alloys, although both arc and induction furnaces have been designed for this purpose. In the February issue of THE FOUNDRY, page 69, a furnace of the arc type for melting nonferrous alloys, was illustrated and described. The metal in this furnace was melted by the heat radiated from a bath of molten glass, which was melted and kept at a high temperature by the arc produced by electrodes in the top and bottom of the furnace. An electric furnace invented in Germany, known as the Hellberger electric transformer crucible furnace, resembles an ordinary tilting crucible furnace adapted for coke or oil, as far as the external shape of the melting chamber is concerned. The tilting mechanism is somewhat different from the ordinary fuel furnace and operates through the medium of a chain attached at one end to the bottom of the furnace and at the other to a device similar to a windlass, which is mounted on top of the transformer at the rear of the furnace. The trunnions on the furnace are at the front, near the top, and the elevating mechanism being high-

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form

STANDARD SPECIFICATIONS FOR STEEL CASTINGS*

1.—These specifications cover two classes of castings, namely:

Class A, ordinary castings, for which no physical requirements are specified.

Class B, castings for which physical requirements are specified. These are of three grades: Hard, medium and soft.

2.—(*a*) Patterns shall be made so that sufficient finish is allowed to provide for all variations in shrinkage.

(*b*) Patterns shall be painted three colors to represent metal, cores and finished surfaces. It is recommended that core prints shall be painted black and finished surfaces red.

3.—The steel may be made by the open-hearth, crucible, or by any other approved process.

4.—(*a*) Class *A* castings need not be annealed unless so specified.

(*b*) Class *B* castings shall be allowed to become cold; shall then be reheated to the proper temperature to refine the grain, and allowed to cool slowly.

Chemical and Physical Properties and Tests

5.—The steel shall conform to the following requirements as to chemical composition:

	Class A.	Class B.
Carbon	Not over 0.30 per cent	....
Phosphorus	Not over 0.08 per cent	Not over 0.05 per cent
Sulphur	....	Not over 0.05 per cent

6.—To determine whether the material conforms to the requirements specified in Section 5, an analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt. Drillings for analysis shall be taken not less than ¼ inch beneath the surface of the test ingot. A copy of this analysis shall be given to the purchaser or his representative.

7.—A check analysis of Class *B* castings may be made by the purchaser from a broken tension or bend test specimen, in which case an excess of 20 per cent above the requirements as to phosphorus and sulphur specified in Section 5 shall be allowed. Drillings for analysis shall be taken not less than ¼ inch beneath the surface.

8.—(*a*) The steel for each grade of Class *B* castings shall conform to the following minimum requirements as to tensile properties:

	Hard.	Medium.	Soft.
Tensile strength, pounds per square inch	80,000	70,000	60,000
Yield point, pounds per square inch	36 000	31,500	27,000
Elongation in 2 inches, per cent	15	18	22
Reduction of area, per cent	20	25	30

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

9.—The test specimen for soft castings shall bend cold through 120 degrees, and for medium castings through 90 degrees around a 1-inch pin, without fracture on the outside of the bent portion.

10.—In the case of small or unimportant castings, a test to destruction on three castings from a lot may be substituted for the tension and bend tests. This test shall show the material to be ductile, free from injurious defects, and suitable for the purpose intended. A lot shall consist of all castings from the same melt, annealed in the same furnace charge.

*Adopted June 1, 1912, by the American Society for Testing Materials.
These specifications supersede the Standard Specifications for Steel Castings, published on Data Sheets Nos. 11 and 12, February, 1908.

STANDARD SPECIFICATIONS FOR STEEL CASTINGS

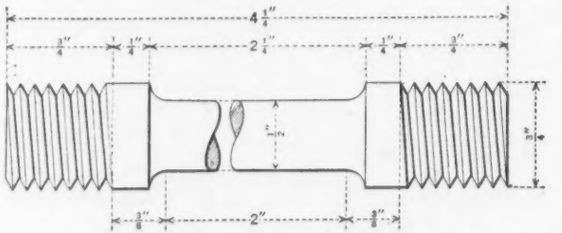
(*Continued from Data Sheet No.* 121.)

11.—(*a*) Test bars shall be attached to Class *B* castings weighing 500 pounds or over, provided the design of the castings will permit. If the castings weigh less than 500 pounds, or are of such a nature that test bars cannot be attached, two test bars shall be cast to represent each melt; or the quality of the castings shall be determined by tests to destruction as specified in Section 10. All test bars shall be annealed with the castings they represent.

The manufacturer and purchaser shall agree whether test bars can be attached to castings, and also on the location of the bars on the castings and the method of casting unattached bars.

(*b*) Tension test specimens shall be of the form and dimensions shown in the accompanying illustration.

Bend test specimens shall be 1 x ½ inch in section.



FORM AND DIMENSIONS OF TENSION TEST SPECIMEN

12.—(*a*) One tension and one bend test shall be made from each melt.

(*b*) If any test specimen shows defective machining or develops flaws, or if a tension test specimen breaks outside the gage length, it may be discarded; and the manufacturer and the purchaser or his representative shall agree upon the selection of another specimen in its stead.

13.—The castings shall substantially conform to the sizes and shapes of the patterns, and shall be made in a workmanlike manner.

14.—(*a*) The castings shall be free from all injurious defects.

(*b*) The castings offered for inspection shall not be painted or covered with any substance that will hide defects, nor rusted to such an extent as to hide defects.

Inspection and Rejection

15.—The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

16.—Castings which show injurious defects before or after machining will be rejected, and the manufacturer shall be notified.

er than the furnace, pulls up the bottom of the latter by winding and shortening the chain. The metal is melted in a crucible, which is heated by resistance on the same principle as the filament in an electric lamp. It is claimed that this furnace has shown high efficiencies. The general design of these two furnaces is radically different; one resembles an ordinary tilting, fuel-fired furnace, and the other, a rectangular box. Regarding the type of electric furnace best adapted to melting non-ferrous metals, there is little doubt but that the induction furnace is the most suitable. One furnace of this type contains a ring of refractory material provided with an annular slot, in which melting takes place by means of an induced current which passes through the metal. To start this furnace cold, it is necessary to have a continuous conductor in the bottom of the melting slot, in which the metal collects when it melts. The ring, of course, should be formed of metal having the same composition as the alloy it is desired to melt. The opinion prevailed that this type of furnace was greatly handicapped by the narrowness of the slot, which made it necessary to add the charge in very small pieces, but this difficulty has been overcome by expanding the upper part of the slot at one or more places around its circumference. By this arrangement it is possible to melt longer ingots than can ordinarily be handled in a crucible. One end of the ingot is placed in the metal and it sinks down into the bath as rapidly as it is melted. A furnace of this type is well adapted for melting non-ferrous metals, and there is every probability that it will prove very economical.

Phosphorized Alloys

We would like to obtain some information about phosphor bronze; we have read statements repeatedly to the effect that no more phosphorus should be used than is sufficient to deoxidize the alloy and that any excess left in the metal is detrimental. On the other hand, it is found in practice that phosphor bronze frequently contains large amounts of phosphorus, and in our own practice it is not uncommon for the specifications to demand as high as 1 per cent of phosphorus in the finished castings. What reasons exist for this divergence of opinion?

The explanation of this difference of opinion is due to the fact that the term *phosphor bronze* is very general in its application, and covers a large number of alloys adapted for widely differing purposes. In some cases the phosphorus is used merely as a deoxidizer and theoretically has served its purpose with the removal of the oxides. In other alloys phosphorus is used as a hardener and this class often contains a considerable amount of phosphorus when cast. These alloys constitute the true phosphor bronzes. The alloys, on the other hand, in which phosphorus is used merely as a deoxidizer, cannot be classified as phosphor bronzes. They are deoxidized alloys, usually being gun metals, which can be cast with the same facility as ordinary bronze. The use of phosphorus will improve any alloy of copper and tin, with or without zinc, and small additions are of material advantage in the yellow alloys. Generally speaking, the deoxidized alloys are used where a ductile metal is required, and the phosphorized metals for bearing purposes. Frequently a considerable amount of lead also is included, as this metal adds to the antifrictional qualities of the alloy.

Mixtures for Marine Brass Work

Can you give me a formula for a composition containing 95 per cent of copper, balance tin and zinc, in any proportions that would be suitable for marine work weighing from 100 to 1,000 pounds and over? The other 5 per cent may consist of any metal that would add to the tensile strength of the copper and make an alloy the tensile strength of which must not be less than 30,000 pounds to the square inch. Can this composition be melted in an oil furnace successfully?

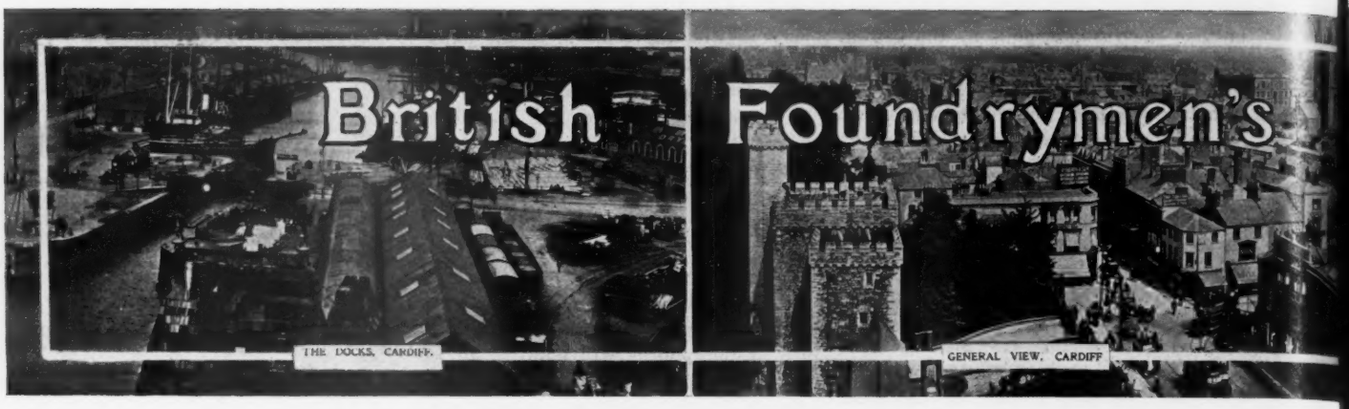
To obtain an alloy suitable for this class of work, it will be necessary to use more than 5 per cent of alloying metals with the copper, otherwise the bronze will be too soft. It is possible that an alloy consisting of copper, 92 per cent; tin, 5 per cent, and phosphor-copper, 3 per cent, might prove of value for some marine work, and would be very near the requirements of 95 per cent copper, but it would be more satisfactory to use alloys suited to the particular class of work in hand, irrespective of their copper content. In the case of large bearings, for instance, an alloy consisting of copper, 80 per cent; tin, 10 per cent, and lead, 10 per cent, would be far superior to any alloy that could be made with a content of 95 per cent copper. Where a metal of high tensile strength is required, an alloy consisting of copper, 90 per cent; phosphor-tin, 5 per cent, and tin, 5 per cent, would be eminently suitable. For some kinds of marine castings, yellow brass would be the most suitable alloy, and other castings might be made from red brass scrap; therefore, it will be better to employ as many alloys as may be required by the character of the work. Any of these alloys can be melted in an oil furnace with perfectly satisfactory results.

Casting Brass Into Steel

We have a number of brass castings to make that are to be fitted into steel tubes. The castings are circular in form with a stem or hub projecting from one side and are threaded, being screwed into the ends of the tubes. The mixture we use, follows: Copper, 85 pounds; tin, 10 pounds; zinc, 3 pounds, and lead, 2 pounds. Instead of threading these bronze hubs and screwing them into the tubes, we would like to know how to cast them in, as this would effect a considerable economy. We have attempted to accomplish this, but find that the bronze shrinks away from the tube and the hub is loose instead of fitting tightly.

We doubt if you will be able to improve upon your present method of making the brass castings separately and threading them into the ends of the tubes. There is no way in which the shrinkage of the bronze can be eliminated, therefore, the only way in which the plugs can be firmly fitted into the tubes, is by preparing the ends of the latter in such a manner that the bronze will seat itself into the tube. This will necessitate as much machine work as threading, and the insertion of the tubes into the molds will consume so much time that the output of castings will be decreased fully 50 per cent. If there is any other reason than that of economy for casting in the plugs, we suggest that the ends of the tubes be slotted by a saw, at six equidistant points, to a depth equal to the depth of the bronze plug. The slots should be at least 1-16 inch wide, so that the metal can flow into these slots. The job would be improved by dovetailing the slots, and it will be found advisable to flow off the metal in order to heat and expand the tube. The latter should be clean and free from scale or oxide, otherwise the castings will blow. Another method that might be suggested is to clean the ends of the tubes, then immerse them in a pot of molten brazing solder so as to tin the ends, or brass-coat them by the hot method. It will be necessary to flow-off the metal when casting the plugs and the bronze will melt the brass coating and firmly unite therewith.

F. Walter Guibert, 327 Ford building, Detroit, has been appointed sales manager by the Frontier Iron Works, Buffalo, of their cylinder casting trade in the central west.



Report of the Proceedings and

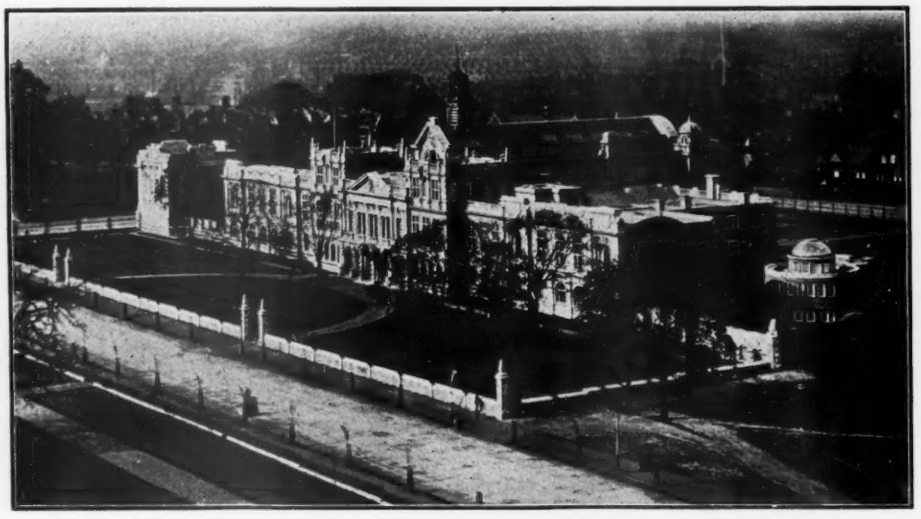
By J Horton.

CARDIFF, Wales, which claims to be the largest of the world's coal ports, was this year the August rendezvous of the British foundrymen. This will be the last of the August conferences since, by resolution, the members authorized their council to arrange for future gatherings some time in the month of May. The month of August is peculiarly unfortunate for Scotchmen, who were poorly represented. One of the most serious disadvantages is that works are generally closed and can only be seen, therefore, in a state of inactivity. The Cardiff conference was exceedingly successful from the point of view of practical utility, the papers being the best set yet presented. Unfortunately, the weather was unpropitious and the earlier proceedings were marred by practically continuous rain. The meeting place itself is of unusual interest and one of the features which afforded much pleasure to the members was the handsome and well-bound souvenir which contained the emblem of the British Foundrymen's Association and excellent photographs of former Presidents R. Buchanan, H. Pilkington, F. J. Cook, Percy Longmuir, the newly-elected president, C. Jones, S. A. Gimson, vice president, and J. E. Allbut, secretary.

Cardiff has so many features of interest, especially as an industrial center, that a few details regarding it may serve to introduce the report of the proceedings. Its public buildings and especially its magnificent university, where the meetings were held, place it in the front rank of Great Britain's leading municipalities. The city is ancient in origin, but its rise as a commercial port is entirely the outcome of modern conditions. The South Wales coal field is the foundation of Cardiff's greatness. Until a little over 100 years ago, coal and iron from the British mills were brought to Cardiff on the backs of mules. In 1798 the Glamorganshire canal, starting at Merthyr Tydfil, was made navigable to Cardiff and the great commercial era of the city began.

It is to its great system of docks, however, that Cardiff owes its present position as a port. This was inaugurated in 1839, by the opening of the West Bute dock. Though Cardiff has grown into a fine city, its great sight is still the Bute docks, which were visited by the members of the convention on Wednesday afternoon, Aug. 7. The latest addition is the Alexandra dock, opened in 1907 by the late King Edward VII.

A large import trade has grown up and the docks are provided with extensive warehouses, wharves, cold storage and other facilities, including a large cattle lair with slaughter houses for dealing with North and South America, and other live imports. Cardiff also has exceptional facilities in the way of dry docks and ship repairing yards, and ships now come long distances to the port for repairs. Cardiff also holds the position of the first port in the Kingdom for shipping cleared to foreign countries. The annual output of the South Wales coal field has increased in 55 years from 8,500,000 to over 50,000,000 tons, and, in its proportion to that of the United Kingdom from 13.1 to 19 per cent. In addition to the Cardiff docks, with their 163 acres of water area, and an annual import and export trade of over 12,000,000 tons, the trade of the port



UNIVERSITY COLLEGE, CARDIFF, WHERE THE MEETINGS WERE HELD

Discussions of the Papers Read

Staff Correspondent

is served by the harbor and docks at Penarth, 4 miles south of Cardiff, to the inspection of which many of the foundrymen devoted the evening of Wednesday. The annual trade of Penarth, which 50 years ago was a small village is 4,500,000 tons, while that of the Barry dock, a more distant adjunct of the port of Cardiff, created within the last 40 years, is over 10,250,000 tons.

The city of Cardiff, which has a population of about 190,000, has done its best to grow in dignity and attractiveness with the growth of the port. It has a number of fine parks, in one of which—Cathays park—sites have been found for a number of handsome public buildings, including the city hall, the law courts, Glamorganshire county hall, the Welsh national museum, all designed to form a harmonious group. One of the latest additions is the University College of Wales, the meeting place of the foundrymen's convention.

BRITISH FOUNDRYMEN AT THE PENARTH DOCKS, CARDIFF

About 80 members assembled in a lecture room of the University College, on Tuesday, Aug. 6, Percy Longmuir, the retiring president, presiding. The members included a large contingent from London and from every important engineering center in the kingdom, including Glasgow, Manchester, Bristol, Leeds, Chesterfield, Portsmouth, Halifax, Gloucester, etc. The visitors included Prof. Campion, of Glasgow, and at an early stage of the proceedings Principal Griffiths, the head of the Cardiff University, delivered a strong address on "The Value of Science as an Aid to Industry." The heads of the association were well represented, all the ex-presidents, namely R. Buchanan, H. Pilkington, F. J. Cook and Percy Longmuir, being in attendance, with F. W. Finch, treasurer, S. A. Gimson, vice president, and J. E. H. Allbut, secretary.

The retiring president, Mr. Longmuir, offered, on behalf of the council, a hearty welcome, anticipating a very useful conference with so large an attendance. A noteworthy feature, introducing an international element for the first time, was the presence of P. Delalande, representing the Association Technique de Fonderie, a French foundrymen's association, having its headquarters at Charlville. The French visitor received a hearty reception. Officers were elected and the installation of Chas. Jones to the chair was carried with acclamation. Mr. Longmuir complemented his successor as a very successful man of business, a practical foundryman and a comrade of unfailing good humor. F. J. Cook, in seconding, emphasized the president's enthusiasm in spreading education among young foundrymen by the awarding of prizes, the payment of school fees, etc. The new president modestly doubted his ability to follow such an array of brilliant occupants of the chair, but said he would be greatly helped by their sympathy and support. S. A. Gimson was promoted to the senior vice chair, and W. Mayer, of Leven Bank Foundry, Dumbarton, Scotland, was elected junior vice president. F. W. Finch was re-elected treasurer, and J. E. H. Allbut, secretary.

The members of the new council follow: T. H. Firth, Sheffield; G. B. Henderson, Southampton; W. H. Hatfield, Sheffield; T. Macfarlane, Horsehay, Shropshire, J. Oswald, London, and J. Smith, South Shields.

R. Buchanan introduced a resolution having for its object a change in the time of holding the conference from August Bank Holiday to a convenient date in May, to be chosen at the discretion of the council.

Mr. Buchanan, who spoke with the authority of the first president, said they had pretty well exhausted the list of places at work on Bank Holiday, and it was well-known that the opportunity of visiting works was at least an equally strong attraction to members visiting the conference with the opportunity of hearing and reading papers. Mr. Dowding suggested that the example of the American foundrymen should be followed by the introduction of an exhibition of foundry appliances. Percy Longmuir, while supporting the proposal, strongly opposed the suggestion of the exhibition, pointing out that they had very high ideals in the past and should guard against mixing up the association with advertising in any shape or form.

Annual Report

The annual report and financial statement read by the secretary showed that six council meetings had been held during the year. All the branches were doing excellent work and two new ones had been formed at Halifax and Newcastle-on-Tyne. The branches comprise Birmingham, Halifax, London, Lancashire, Newcastle-on-Tyne, Sheffield and Scottish. The membership roll now totals 889, compared with 674 a year ago. The total revenue for the year was £412 13s 1d, and the expenditure £318 6s 7½d, leaving a balance of £94 6s 4½d, and a total sum in hand of £196 7s 3d.

Formal business having been completed, Principal Griffiths, the head of the university, delivered an address on "The Value of Science as an Aid to Industry." He regarded the presence of the foundrymen as of some significance, especially as indicating their belief that practical applications of science should to some extent go hand in hand with theoretical work. This has been grasped in Germany to a much greater extent than in Great Britain, and it was also being grasped in the United States. He added that the prosperity of the old country depends on its industries, and they in turn depend on the applications of pure science. What is wanted is an educational system which will form the link between the laboratory and the market place. That is where Britishers are defeated by the Germans who are training scientific business men able to apply the discoveries of the laboratory to practical purposes more quickly than Englishmen.

CHAS. JONES, PRESIDENT B. F. A.

Presidential Address

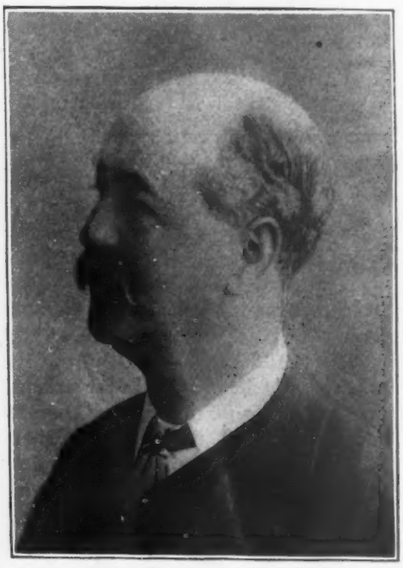
Charles Jones, newly-elected president, then delivered his inaugural address, which was in part as follows:

"With the rapid growth of our association, the responsibilities of its officers have naturally increased, and when it is recalled that on the occasion of our first convention in 1904, at Manchester, our membership was only 83, it will be at once acknowledged that the progress of this organization during the intervening years has been little short of phenomenal. We number today 910 members, and this fact alone is sufficient evidence that the work and objects of our association appeal to, and are appreciated by, the members of our trade, and that our existence as an educational body has been amply justified.

"We foundrymen are, of course, proud of the antiquity of our craft, but ancient methods must give way to modern requirements, and as each progressive step takes place in the advancement of our work we must as employers and managers fall into line, or get left behind in the forward march of the present day.

"Now it appears to me that there is much to be done, and much that the British Foundrymen's Association can do in this matter of education. We must admit that all the theoretical knowledge in the world cannot make a practical molder, but to the practical workman the theoretical knowledge to be obtained at technical schools and colleges is invaluable. There are, no doubt, many present who, like myself, deeply regret that in their youth the opportunities did not exist for the acquirement of that sound, scientific, technical and commercial knowledge which today is so readily placed within the reach of all; and with a full recognition of the immense benefits to be gained, it should be our duty not only to encourage and assist apprentices to attend technical classes generally, but to take the necessary steps to obtain the inclusion in the syllabuses of our technical schools of a class in foundry work.

"But even after an educational authority has agreed to the teaching of a certain subject, there is frequently a difficulty about the formation of a class. Technical schools generally insist on the enrollment of a minimum number of students, from 10 to 20, and it occasionally happens that a subject is cancelled, owing to the failure of a sufficiency of students to make up the requisite number.



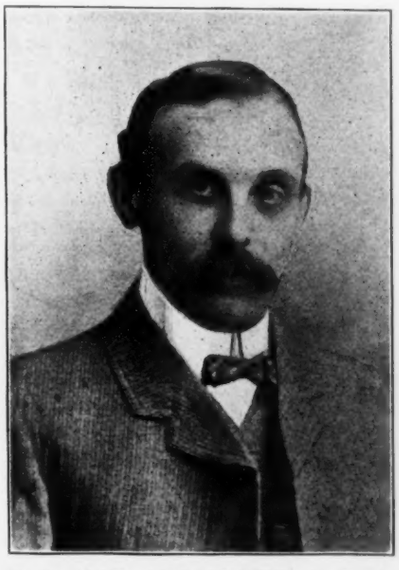
S. A. GIMSON, SENIOR VICE PRESIDENT B. F. A.

J. E. H. ALLBUT, SECRETARY B. F. A.

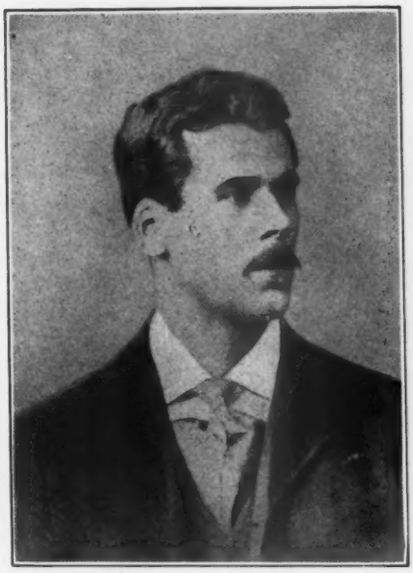
This is where the influence of the individual employer and manager may be useful in encouraging lads to attend the class, even to the extent, if necessary, of paying the fees. By showing personal interest, a great deal can be done toward stimulating a lad's enthusiasm for his work, and a few words of encouragement and advice to an apprentice may be all that is necessary to persuade him to attend the class.

"And I may here put in a plea to technical teachers for simplicity of language. Even with our system of compulsory elementary education the majority of our boys are not trained to understand severely technical terms and scientific formulae, and I, unfortunately, know instances in this city where certain classes have been failures, simply owing to the inability of students to digest the instruction given. It is, therefore, very necessary indeed, in order to make a technical class a success, that the student may be interested as well as instructed. We cannot expect every educational authority to lay down a foundry plant, but surely we should depend on employers giving some practical assistance by placing a portion of their foundries at the disposal of the teacher. There are so many little things that they may be shown and taught in the familiar surroundings of the workshop, so many questions that can be asked and answered, that nothing but good can fail to come from such a form of instruction.

"Encouragement can also be given by employers and managers in offering local prizes, and in the cases of well-educated and ambitious apprentices, I would advocate the attendance at classes in other subjects kindred to the trade, and I earnestly support the suggestion of our council with regard to the establishment of national scholarships for the most proficient students in foundry work and the allied subjects. Such scholarships would not only be an inducement to lads to use their education as a stepping stone to better their position from that of an ordinary molder but in my humble opinion would eventually do good work in raising the status of our workmen. The apprentice of today is the workman of tomorrow and I cannot hold with the system of using lads purely as money-making machines by keeping them at routine work which however remunerative to the employer for the time being, must mean a poor prospect for the lad.



F. J. COOK, EX-PRESIDENT B. F. A.



PERCY LONGMUIR. RETIRING PRESIDENT B. F. A.

"In my opinion, the suitability of the jobbing shop as a training ground is greater than that of the large concern, where the work of one day is largely a repetition of that of the day before. But the necessity for skilled and careful workmen is the same, and, unfortunately, in many workshops the apprentice does not get the advice and assistance from the skilled workmen to which he is fairly entitled. The old hand, with his years of experience does not impart his acquired knowledge very readily. He has always before him the day when he will be replaced by a younger and possibly more capable workman and he hoards his knowledge with what is after all a perfectly natural selfishness. In these days, however, of socialistic tendencies, it is gradually being recognized that the state has a clear and imperative duty toward the aged and infirm workman and if this principle be ultimately realized, then it will become the duty of the workman to the state, to impart, to the best of his ability, the skill and knowledge which his long experience has given him. But apart from the matter of state duty, let us encourage our foremen and journeymen to help the apprentice, and, to this end, let the British Foundrymen's Association, as a purely educational body, do all in its power to extend its membership.

"I am convinced that if the various employers could only be made to recognize the advantage of membership to their workmen, and consequently to themselves, there would be little difficulty in obtaining from them that encouragement and support—moral and financial—which we ought to have in a much greater degree than we have at present.

"The educational advantages of belonging to local branches of the association must not be overlooked, and I hope that my year of office will see the establishment of one or two additional branches in our industrial centers, branches which I fondly hope will be the means of obtaining for their members that proportion of technical education to which the foundry industry is clearly entitled."

Training Apprentices

"The Training of Apprentices," by J. W. Horne, was the first paper presented. The author prefaced his address with an expression of delight at the remarks made by Principal Griffiths on the subject of higher technical education, while he was

HERBERT PILKINGTON, EX-PRESIDENT B. F. A.

MEMBERS OF THE BRITISH FOUNDRYMEN'S ASSOCIATION WHO ATTENDED THE CONVENTION AT CARDIFF, WALES.

Left to Right in Each Row:—Top Row: 1, T. R. Schofield; 2, Mr. Barningham; 3, H. Grandidge; 4, J. G. Robinson; 5, W. E. Noon; 6, H. I. Coe; 7, J. Kerfoot; 8, M. H. Curnow; 9, A. Hamilton; 10, P. Delalande; 12, D. G. Mather; 13, T. McFarlane; 14, W. H. Garbutt.

Second Row: 1, H. P. Mason; 2, J. B. Durrans; 3, W. Smalley; 4, W. Sykes; 5, T. Feasey; 6, D. Dalrymple; 7, B. E. Lewis; 8, J. B. Tattersall; 9, F. Penlington; 11, F. J. Cree; 13, W. Williams.

Third Row: 1, R. H. Greaves; 2, S. G. Smith; 3, F. J. Cook; 4, G. B. Henderson; 5, J. Ellis; 6, H. Pilkington; 7, C. Jones; 8, R. Buchanan; 9, P. Fox-Allin; 10, W. F. Bagnall; 11, T. Baugh; 12, G. M. Mather.

Fourth Row: 1, Prof. A. Campion; 2, J. W. Horne; 3, H. S. Green; 4, H. Jewson; 5, W. Harrison; 6, J. E. H. Allbut; 7, H. Griffiths; 8, H. Winterton; 9, J. G. Dobson; 10, J. C. Miller; 11, E. Blackmore; 12, M. Riddell.

also pleased with the expressions of President Jones on the relations which should exist between the apprentice and the employer. The speaker expressed his disapopintment with the poor success he had attained in seeking to interest young apprentices in foundry literature.

The discussion was opened by R. H. Greaves, of Cardiff University, who pointed out that foreigners were progressing in education on lines practically untouched in Great Britain. He noted that, with regard to foreign countries, in no case is theoretical training made an additional burden on an already hard-worked boy. The speaker suggested a happy combination of education with a form of social interest in the welfare of the youth.

R. Buchanan thought they might congratulate themselves that, even now, the apprenticeship system is in fairly strong force throughout the engineering and jobbing foundries of the kingdom. He stated that it was very unfortunate that the foundry had, as a rule, attracted the less intelligent youths, and he feared that the industry would not get the better educated. He entirely agreed with Mr. Horne that there was a sad neglect by employers of the duty to take a personal interest in the apprentices.

J. W. Jewson demurred to the suggestion that there was a duty laid upon the employer to supervise the boys in regard to moral and physical development. That was a duty clearly devolving upon the father and mother, and the employer could only do it in a makeshift way. While he generally approved of the alternate study in the workshop and the school, that would seem to necessitate doubling the number of apprentices, and would very likely cause difficulties in future.

Unsatisfactory Raw Material

H. Pilkington said it was very significant that the association should be so much occupied with educational matters. The great difficulty was the very unsatisfactory raw material sent from the schools. He believed that the whole conception of primary education is wrong. Many boys are not in position to grasp the secondary education which the schools seek to give. The most successful ventures are the special schools carried on by members of the works staff. He agreed that, under the system of limited companies, the personal interest in the boys is disappearing.

J. Smith said that the best possible training is to let the youth work in a variety of shops as there is no better training than to go from one foundry to another. He admitted that the molder is looked upon as a lower type of mechanic, inferior to the patternmaker, but he knew of no trade requiring greater intelligence, patience and skill. The social intercourse between the foreman and the apprentice was of the greatest value. The trade had been injured by the disposition of some employers to use the youths as money-making machines, with absolute carelessness as to their future.

Sympathy for Apprentices

F. J. Cook said that the low grade of youth that comes into the foundry is unfortunate, but as he had a good deal of sympathy for the boy who felt he had had enough when he had worked from six o'clock till six o'clock in the foundry he would not advocate compulsory attendance. His firm, that of Bellis & Morcom, has taken a great interest in the training of apprentices, and to attract a better class of youths, it offers higher wages in the foundry than in other departments of the works. This firm helps its apprentices by means of scholarships which carry them to the technical school, and subsequently to the university for three years, during which time they are paid their wages, just as if fully employed at the works. Thus far this system has not been as successful as desired, but he was glad to note a keener desire for practical knowledge of foundry work. He was still in search of better boys, though he was glad to say that the classes which he had induced his foreman to carry on at his own home for two nights a week, and which had existed for two years, had been most successful. Those classes attracted young men from 18 to 30 years of age. The speaker concluded by proposing that the council appoint a sub-committee to consider the best means of assisting the work of practical education.

Prof. Campion, replying to some complaints of want of simplicity on the part of university teachers, said it was not always very easy to be entirely simple in dealing with technical subjects. His classes last year comprised students varying in age from 16 to 66, and they generally had five or six men well over 50. Compulsion did not exist except in a few cases. The foundry foreman recommended, but did not compel attendance at classes. Prof. Campion said it was a great step in advance to have co-ordination and co-operation between the scientific and the commercial side of metallurgical work. Above all, they tried to make their men think. With regard to the home training referred to, the responsibility for that was being shifted off the shoulders of the parents to that of the teacher and employer. He heartily supported the suggestion for the establishment of a special sub-committee and the motion was carried.

A written contribution to the discussion of the paper by Mr. Horne was received from Alexander Hayes, of the London branch. The writer considered the essence of the problem lay, not so much in definite technical instruction in each special trade, as in the general development of the intellectual powers of the boy from the age of 14 to about 18. Adequate treatment should cover every trade, including what was often erroneously called unskilled labor, which was really often the dearest kind of labor. The great difficulty was that youths commenced performing routine operations before the boy was intelligent enough to understand the relation between his own particular process and the whole trade. It was unfortunate that individual firms initiating such a movement must bear considerable expense, and under highly competitive conditions most firms would stand a great risk of extinction if they set out to eliminate unskilled, uneducated and low-paid labor.

Visit to Dowlais Steel Works

The afternoon was occupied by a visit to the Dowlais Steel Works, situated about 3 miles from Cardiff. The property is owned by Guest, Keen & Nettlefolds, Ltd., which now represents an amalgamation of several of the largest firms in the United Kingdom. The works were founded 30 years ago and were acquired by the present owners in 1900. They comprise steel works and plate mills and the products include pig iron and steel slabs and plates for boilers, ship building, girder work, etc. The plant is driven by electricity, generated from furnace gas.

A party of ladies and gentlemen, numbering over 200, accepted the invitation of the Lord Mayor and the Lady Mayoress to a reception given in honor of the convention in the magnificent city hall, which is situated, like the University college and other new public buildings, in Cathays park. The guests were received by the Lord Mayor and Lady Mayoress in the assembly room. In ad-

dition to the president and the members of the British Foundrymen's Association, a number of representative citizens accepted invitations. A most enjoyable program of music was rendered by a string band.

Wednesday's Proceedings

The convention, on Wednesday morning, again met in the University college. H. I. Coe gave an abstract of his paper on "The Influence of Sulphur on Cast Iron." H. Pilkington referred to his long standing controversy with Prof. Turner with regard to the suggested impossibility of high sulphur existing with high silicon and said that he had supplied Prof. Turner with evidence of the fact that high sulphur could and did exist with high silicon in pig iron. In the ordinary way a siliceous pig iron of course was very low in sulphur; but it was also very graphitic. Mr. Pilkington said that there is plenty of evidence that high sulphur and high silicon, the silicon as high as 4 per cent, exist together in certain pig irons. With regard to the increase of sulphur by re-melting in the cupola, the figure 0.03 per cent given in the paper as the average increase, seemed to him very low. The increase, however, was affected by various conditions, such as the sulphur in the coke and in the scrap, and it was very difficult to determine the cupola increase in any particular case if these conditions were not known. The scrap itself also had a cumulative action in conveying sulphur into the casting. Mr. Coe had mentioned that the bright inclusions which were found in certain bars, which were thought at first to be sulphide of manganese, proved upon analysis to be extruded portions of eutectic, containing 3.03 per cent of carbon.

R. Buchanan said that he had an opportunity of talking with Mr. Levy on this question of sulphur in cast iron and pointed out to him certain facts which did not agree with his theory as to how the sulphur acted. He had another instance under consideration only a fortnight ago. A founder was making certain castings for textile work and had to make them exceedingly soft. The gray iron castings before annealing could be machined easily, but when removed from the annealing furnace the outside had a white, hard skin which could not be touched with a file, though the inside was just as soft as before. He suspected that sulphur was causing the formation of that hard skin and he found about 0.5 per cent of sulphur in the coke dust in which these castings were being annealed, so that it was quite obvious that the hard skin was formed by the castings being in contact with sulphur dust. He recalled a consignment of pig iron which had a curious mottled appearance and on an average this contained something over 3 per cent silicon with 0.15 per cent of sulphur. He asked whether Mr. Coe had gone into the question of small blow-holes or pin holes, because it appeared to him that these were the result almost wholly of the influence of sulphur contained in the iron.

Effect of Sulphur

F. J. Cook said that Mr. Coe's paper had confirmed opinions which he had held for a very long time. He hoped that Mr. Coe would continue his researches further. When Mr. Coe said that a critical point with regard to the percentage of sulphur appeared to exist and that the position of this critical point changed according to the silicon content, he was quite in agreement with Mr. Coe. For a long time he had been of the opinion that there did exist what he might call an equilibrium point with regard to the effect of the percentage of sulphur in the presence of carbon and silicon. That critical point had a very great bearing indeed on the strength of iron and, he believed, on its wearing properties also. He had not had much experience with regard to the actual wearing of parts of machinery, but he was looking forward to seeing an apparatus designed which would test the wearing properties of cast iron. He was quite sure that this critical or equilibrium point had a very great effect on the wearing parts of machinery which was subjected to high temperatures, for instance, 50 per cent. With regard to blow holes, he added, sulphur undoubtedly causes them, but whether they develop or not is entirely a matter of casting temperature. Cast iron could be made successfully with silicon as low as 1¼ per cent and sulphur as high as 1¼ per cent, but the temperature must be high, not only the melting temperature, but also the casting temperature.

Prof. Campion said that although he agreed that it was absolutely necessary to study thoroughly the effect of the various constituents of iron, he would hesitate to take the results of Mr. Coe as conclusive, because they were not made under ordinary conditions. In dealing with these small quantities the conditions must be altogether different from ordinary working conditions. Generally these laboratory results had been taken with only one constituent varying, and without regard to variations in the others. The actual properties of iron were not governed by any one constituent but by all of them. He had pointed out many times that cast iron was, after all, one of the most complex materials. It was not a simple compound nor even a simple mixture. He said there was need of an investigation along the lines outlined in Mr. Coe's paper which should be carried on under actual commercial conditions. He added that he is conducting a series of experiments to ascertain the effect of varying compositions of iron and these are being made as nearly as possible under ordinary working conditions. They were following one constituent at a time, and, as far as possible, were keeping all the others constant, though varying each in turn. He hoped by those experiments to get something nearer to the results obtained under ordinary foundry conditions, because, cooling and casting conditions differed widely in the foundry.

Molding a Water-Jacketed Cylinder

J. D. Robinson then presented, with lantern illustrations, his paper on "Molding a Water-Jacketed Cylinder for a Vertical Gas Engine."

In the ensuing discussion, F. J. Cook said it would have been very surprising a few years ago for a firm like Campbells to allow their foundry manager to explain the methods by which they obtained their results. He was rather surprised to see so many rods in the cores as were shown in the water jacket, because it was generally understood that if oil sand cores were used fewer rods were necessary. An important feature, of course, in the use of oil sand cores, is to have them properly dried, otherwise they have a tendency to blow. With regard to mixing the sand, he had found the best method was to dry it in the core stoves, after which a known quantity of water was added and then the oil.

Mr. Robinson, in his reply, said that possibly there were more rods than were required in the water jacket core, but this number was used for safety.

Mr. Cook said that he had experience with cores which did not steam when removed from the oven, but subsequently had blown. In his

foundry it is the practice to let the cores cool, after which they are blackened and dried in the oven.

Mr. Robinson, continuing his reply, said he found the best core mixture was about 1 of oil to 30 of sand.

"Patternmaking" was the subject of a paper read by T. R. Schofield. The discussion was opened by F. J. Cook, who welcomed a paper on such a practical subject. He agreed with the author in regard to the co-operation of the designer and patternmaker. The pattern, he said, was the foundryman's tool and the molder had a right to be taken into account both in regard to the designs and the construction of the pattern.

Mr. Buchanan said that engineers paid less regard to foundry possibilities when the castings were made outside, and made them more complicated in design than when the casting was done in their shops. One reason perhaps was that outside casting was done at so much per hundred-weight. Engineers were too often anxious to keep down their own costs at the expense of other departments.

Papers on "The Testing of Molding Sands," by Alfred B. Searle, and "Modern Brass Founding," by H. S. Primrose, were read and briefly discussed in the absence of the authors.

This concluded the business of the convention and the members spent the afternoon and evening viewing the Bute docks at Cardiff and Penarth. On Thursday they had a most enjoyable excursion through the valley of the Wye, a district not only of great natural beauty, but also containing a number of old feudal castles of great historical interest.

Buffalo Prepares for Foundrymen's Invasion

FINAL preparations for the convention of foundrymen, which will be held in Buffalo during the week of Sept. 23, are now being made by the various local committees. Present indications point to a record-breaking attendance and the interest manifested in the exhibition by manufacturers of foundry supplies and equipment, machine tool builders, etc., foreshadows one of the largest expositions of this kind ever held by a single industry. The Broadway Exposition building on which alterations have recently been completed at an expenditure of $160,000, has a floor area of 47,000 square feet under a single roof, which considerably exceeds the floor area of either the Madison Square Garden in New York City, or the Coliseum at Chicago. Aside from the supports for balconies paralleling either side of the building, there are no columns on the floor to obstruct the view. The building is unusually well adapted for exhibition purposes and the displays that will be made should prove unusually attractive under these conditions.

Professional Sessions

Professional sessions of the American Foundrymen's Association and the American Institute of Metals will be held on Tuesday, Wednesday and Thursday, Sept. 24, 25 and 26. The exhibition, however, will be formally opened on Monday morning and will be continued until Friday night. The professional sessions of the American Foundrymen's Association will be held in the large convention room at the Statler hotel, which likewise will be the headquarters of this organization. The annual banquet of the Associated Foundry Foremen will be held at the Broezel House on Tuesday evening. On Thursday night a subscription banquet for all visiting foundrymen is scheduled and on Friday a boat ride will be given by the foundrymen of Buffalo. Headquarters of the Foundry and Machine Exhibition Co. will be at the Lafayette hotel, and the American Institute of Metals will locate at the Iroquois. The Broezel House has been selected as the headquarters for the members of the Associated Foundry Foremen.

Ranking ninth among the leading foundry centers of the United States, Buffalo's shops will afford much of interest to visiting foundrymen. Including the iron, brass and steel foundries, there are 66 casting plants in Buffalo. Of this total 20 melt brass exclusively, while there are 41 gray iron shops. As an iron and steel producing center, Buffalo also takes high rank. In this district, including Tonawanda, there are 20 blast furnaces, 11 of which are engaged in the manufacture of iron for the foundry trade. Among the steel works the plant of the Lackawanna Steel Co. is the largest, although others include the New York State Steel Co., the Seneca Iron & Steel Co. and Wickwire Bros.

Thus far this year a total of 78 conventions has been held in Buffalo, which is renowned for its hospitality and its unusual facilities for taking care of large gatherings. The proximity of Niagara Falls, which is only a 55-minute ride by train from Buffalo, greatly adds to the attractiveness of this city as a meeting place for various organizations. In addition to the falls, the industrial development of the city which has been built-up along the Niagara river is wonderful, and many of the plants will be open for inspection by the visiting foundrymen.

The general committee in charge of the convention arrangements consists of H. D. Miles, Buffalo Foundry & Machine Co., chairman; E. W. Sherman, vice chairman; W. H. Barr, Lumen Bearing Co., treasurer, and Geo. C. Lehmann, secretary. The other members of the committee are as follows: W. M. Corse, T. L. Richmond, W. F. Wendt, Willis N. Edwards, Walter F. Semon, F. W. Tracy, Robt. B. Thomson, Geo. V. Horgan, Harold J. Balliett, Frank B. Baird, J. P. Williams, J. M. Olmsted, P. J. Krantz, E. B. McKenna, J. W. Pohlman, D. W. Sowers and Geo. P. Warner.

Chairman of the various other committees have been elected as follows: W. H. Barr, finance; W. F. Semon, reception; T. L. Richmond, printing; Frank B. Baird, entertainment; H. W. Wendt, exhibits, and W. F. Semon, press.

Chicago Foundrymen's Club

The Chicago Foundrymen's Club has made special arrangements for its members to make the trip to Buffalo in a body, and an invitation is extended to all foundrymen and their friends in Chicago, the southwest, west and northwest and at points en route, to make the trip with this organization. A special train will leave Chicago over the Michigan Central railroad at 9 a. m. Sunday, Sept. 22, arriving at Detroit at 3:30 p. m. From Detroit to Buffalo the trip will be made by steamer, arriving in Buffalo at 9 a. m. Monday morning. A sufficient number of staterooms have been reserved on the steamer to take care of all who desire to make this trip. The fare from Chicago to Buffalo is $9.25. Those desiring to make reservations for the journey by this rail and water route should communicate with C. C. Clark, New York Central Lines, Chicago.

THE FOUNDRY

A monthly journal devoted to all branches of the foundry business.

Published by

The Penton Publishing Co.

Penton Building, CLEVELAND

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United States and Mexico - - - - - - $1.00 a year
Canada - - - - - - - - - $1.50 a year
Great Britain and other Foreign Countries - Eight Shillings
Single Copies - - - - - - - - 15 cents

Copies published three months or more previous to date of current issue, 25 cents each.

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All communications relating to advertising copy, discontinuances etc., must be received on the 10th of the month preceding date of publication.

COPIES PRINTED

This Issue - - - - - - 11,000

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Record Pig Iron Production

DURING the first half of this year the pig iron production of the United States reached the enormous total of 14,972,274 gross tons, according to figures compiled by the American Iron and Steel Association. This is at the rate of 28,000,000 tons per year and if maintained, will exceed the total of 1910, which was 27,303,567 gross tons. The output the last half of 1911 was 11,982,551 tons and 11,666,996 tons the first half. In 1909, the total production was 25,795,471 tons; 1910, 27,303,567 tons, and 1911, 23,649,547 tons. That the production of gray iron foundry and malleable grades has increased materially is indicated by these figures. Aside from the production of Bessemer, low-phosphorus, basic and charcoal pig iron, as well as spiegeleisen and ferro-manganese, there were produced 2,835,036 gross tons of other grades, which almost entirely consist of foundry and malleable iron, with a small percentage of forge. During the last half of 1911, this total was 2,468,930 tons, showing an increase of nearly 400,000 tons during the first half of this year. To this tonnage must be added 166,366 tons of charcoal iron during the first half of 1912, and 117,541 tons in the last half of 1911. The increase in the production of foundry grades reflects the greater activity of gray iron and malleable shops during the first half of this year as compared with conditions prevailing in this industry during the last half of 1911. No definite figures are obtainable relative to the consumption of basic iron for steel casting purposes, but this is known to have increased materially during the first half of 1912.

Trade Outlook

THE ACTIVITY of the iron trade is reflected by the sharp advances which recently were recorded on all grades of foundry pig. Large melters throughout the country have been covering their requirements through the remainder of the year and several cast iron pipe interests have contracted for their needs through the first six months of 1913. All branches of the foundry industry are prospering, the demand for malleable castings being particularly heavy. Car shops are fully engaged and large tonnages of iron and steel cast sections are required to meet the demands of this trade. Brass and aluminum foundries have materially increased their melt, following a general resumption of plants engaged in the building of automobiles and motor trucks. The outlook is particularly bright and conditions foreshadow a continuation of the present trade activity. Reports from all parts of the country indicate an acute shortage of labor, with wages tending toward higher levels. Strikes in a number of foundry centers have been declared for a nine-hour day and both gray iron and brass shops have been affected. A notable increase in foundry building operations is noted in all sections of the United States and Canada, which indicates that preparations are being made for a largely increased output. In the leading producing centers, foundry grades of pig iron are quoted as follows: Chicago, northern No. 2, $15.50, and charcoal, $16.75; No. 2, Pittsburgh, $14.90; No. 2, Cleveland, $14; No. 2X, Philadelphia, $16, and southern No. 2, Birmingham, $11.75 to $12. Northern pig iron producers refuse to quote on deliveries beyond the first of the year, although large sales of southern for first half shipment have been made at $12.50 for No. 2.

Equipment for the Foundry and Pattern Shop

Power Roll-Over, Direct-Pattern-Draw and Direct-Draw, Roll-Over, Jolt-Ramming Machines—Grinding Wheel Hoods—Power Squeezer—Stripping-Plate Device

TWO NEW machines have been added to the extensive line of labor-saving molding devices built by the Osborn Mfg. Co., Cleveland. These include a power roll-over, direct-pattern-draw machine for handling half molds weighing from 1,000 to 6,000 pounds and a direct-draw, roll-over, jolt-ramming machine adapted for making molds and cores.

The large roll-over machine, which has a pattern draw of from 6 to 15 inches, is illustrated in Fig. 1. The mold is rammed by hand and is rolled over by the compressed air cylinder shown at the left, which likewise draws the pattern. In Fig. 2 the mold has been rammed and clamped and is ready to be rolled over. The car shown in the foreground, after the mold has been rolled away, is moved into position underneath the flask. It will be noted that this car is provided with a four-pin automatic leveling device, which compensates all unevenness of the bottom board. After the mold has been delivered onto the car the four pins are locked by one operation of the lever shown on the car platform. In Fig. 3 the operation of rolling over the mold is clearly illustrated.

After the flask has been locked, the clamps are removed and the pattern is drawn by the same air cylinder which accomplishes the roll-over operation. In Fig. 4 the pattern has been drawn, after which the car carrying the mold is drawn forward and the mold is lifted off by a crane. To hold the table rigid during the ramming operation compressed air-operated stops are employed.

The machine is simple in construction and contains a comparatively small number of operating parts. Uniform and steady roll-over is insured by the fact that the mold revolves around its center of gravity. This movement further is controlled by friction brakes consisting of a large cam on each trunnion which works against a shoe on the frame of the machine. Flasks up to 6 feet square can be handled.

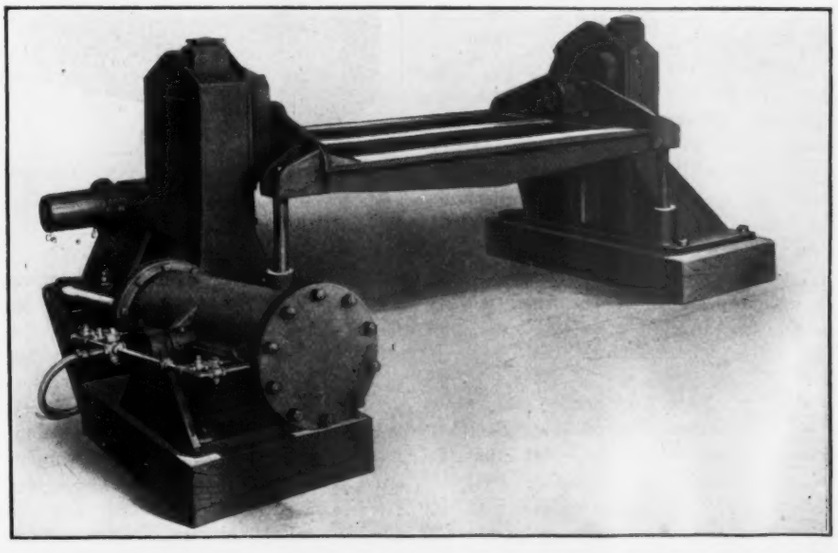

FIG. 1—POWER ROLL-OVER, DIRECT PATTERN DRAW MOLDING MACHINE

The direct-draw, roll-over, jolt machine is illustrated in Figs. 5 and 6. In Fig. 5 the pattern is mounted ready for ramming and in Fig. 6 the mold has been rammed and the pattern drawn. This type of machine has been in daily operation in one of the largest foundries of the country engaged in the manufacture of automobile and marine gas engine castings. The flask or core box is supported on trunnions which can be easily adjusted to flasks from 10 to 32 inches outside length and for any width up to 24 inches. The maximum pattern draw is 10 inches. One cylinder is used for jolt-ramming the mold and drawing the pattern. The mold or core can easily be rolled over by hand as it revolves on an axis passing near its center of gravity. While drawing the pattern, the mold is held in perfect alignment with the pattern by a simple locking device. The table is equipped with an automatic, four-pin leveling attachment, the pins being locked by one movement of the lever. The flask rests on sliding steel arms which permits the mold to be drawn out clear of the table and easily removed. This machine is particularly well-adapted for molding small, deep patterns used in automobile and similar work. The machine is built in three sizes for making piston rings, pistons, cylinders, crank cases, flywheels, brake drums, crank case cores, jacket cores, etc.

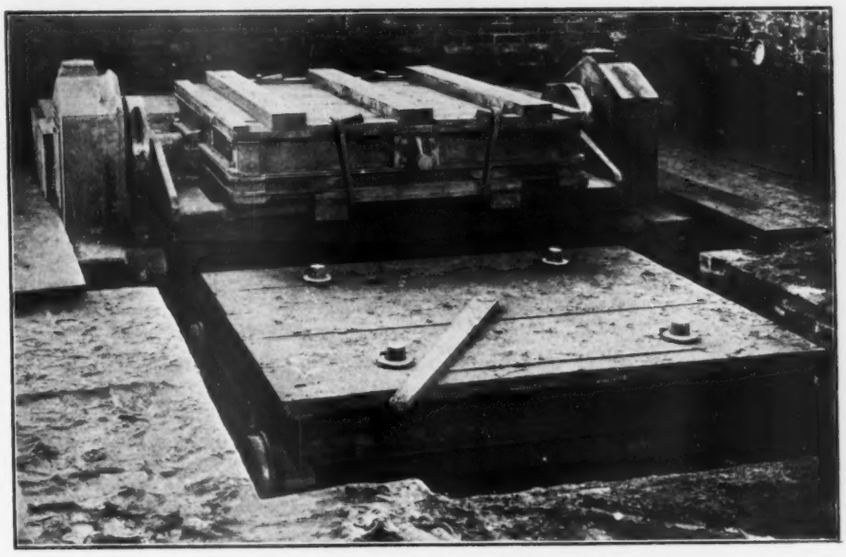

FIG. 2—MOLD RAMMED READY TO BE ROLLED OVER

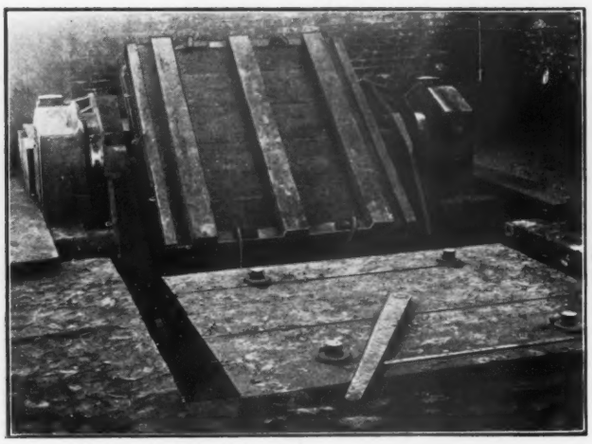

FIG. 3—ROLLING OVER THE MOLD

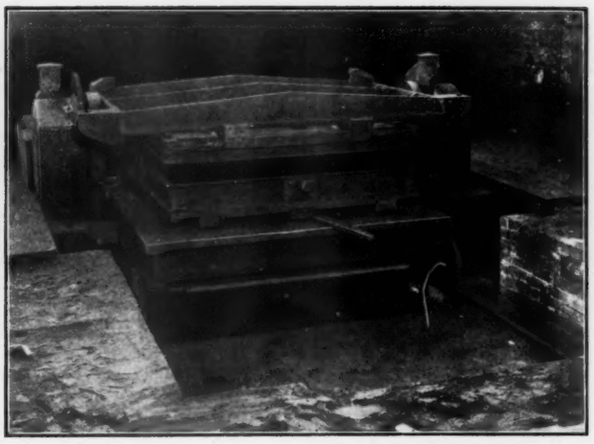

FIG. 4—PATTERN DRAWN BY COMPRESSED AIR CYLINDER USED FOR ROLLING OVER

Mesta Machine Co.'s Products

The plant and product of the Mesta Machine Co., Pittsburgh, is illustrated and briefly described in a 48-page booklet issued by this company. These works are located at West Homestead, about six miles from the business center of Pittsburgh. The plant covers about 20 acres and contains approximately 500,000 square feet of floor space under roof, over 400,000 square feet of which are commanded by electric traveling cranes. The buildings, which consist of the general office, machine, forge and pattern shops, pattern storage, iron, steel and brass foundries, are of fireproof construction, being built of steel, brick and concrete. The principal products of the plant consist of machinery for steel works, blast furnaces and power plants, including gas and steam engines, condensers, air compressors, steam-hydraulic forging and bending presses, rolling mill machinery, iron and steel rolls and pinions and machine-molded and cut gears. The foundry is equipped to make castings weighing over 100 tons.

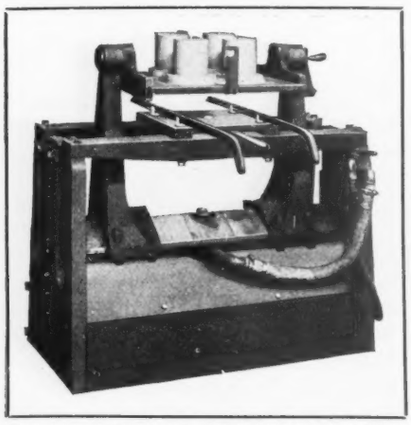

FIG. 5 — DIRECT DRAW, ROLL-OVER JOLT MACHINE WITH PATTERN READY FOR RAMMING

George Saunders Bullock

George Saunders Bullock, eastern representative of the Whitehead Bros. Co., Providence, R. I., during the past 35 years, died at his home at Warren, R. I., on Thursday evening, Aug. 8, after an illness of only a few days. Mr. Bullock was well-known in the foundry trade throughout the entire New England territory.

Cleveland-Wadsworth Sand Blast Machine

The Cleveland-Wadsworth sand blast machine, manufactured by the J. D. Smith Foundry Supply Co., Cleveland, is designed for sand-blasting all classes of castings, including iron, steel and brass. None of the working parts is in the machine proper, and it is without hand or cleaning holes. The flow of sand is controlled by a trap at the bottom and for this reason a sand valve is not necessary. The sand admitting valve in the top is opened by air pressure, permitting the sand to flow into the tank. Changing the air from the sand filling valve to the inside of the tank throws the valve up, cleans the seat and seals it. The machine is furnished with a sand-filling tank which may be removed for receiving the sand to be returned to the sand blast tank. The machine also is furnished with a water separator.

Richard Law, formerly connected with the Lumen Bearing Co., Buffalo, has accepted a position with the H. Mueller Mfg. Co., Decatur, Ill., as foundry foreman and metallurgist of their new Canadian plant to be placed in operation shortly at Sarnia, Ont.

Solder for Aluminum

The difficulties experienced in soldering aluminum have stimulated the inventive faculties of metallurgists to such an extent that new discoveries are being announced from time to time. One of the latest additions to the number of these alloys has been recently patented by Geza Hartmann, of San Francisco, and R. J. Busch, of Los Angeles, who claim that a very superior alloy can be made as follows: Tin, 66 per cent; aluminum, 15.5 per cent; bismuth, 9 per cent; antimony, 7 per cent; magnesium, 2.25 per cent, and vanadium, 0.25 per cent. The claim is made that the vanadium is first melted in a covered graphite crucible and that the bismuth, aluminum, antimony and magnesium, are added in the order named, powdered charcoal being used to exclude the air. The mixture is thoroughly stirred to incorporate the ingredients, after which the tin is added and the alloy is once more thoroughly stirred, then skimmed and poured into ingots.

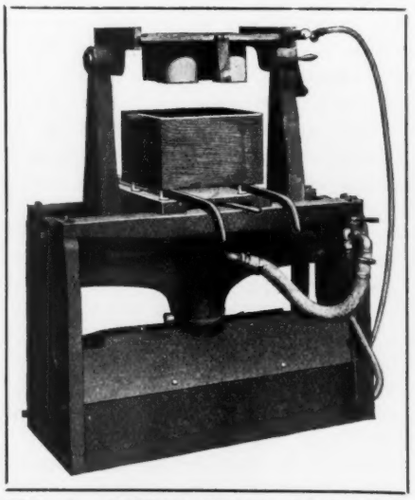

FIG. 6 — DIRECT DRAW, ROLL-OVER JOLT MACHINE, SHOWING THE MOLD RAMMED AND PATTERN DRAWN

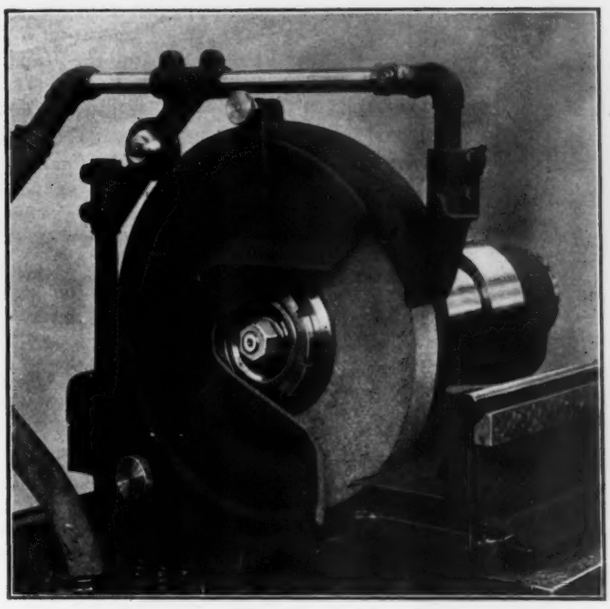

FIG. 1—PROTECTION HOOD USED ON NORTON PLAIN GRINDING MACHINE

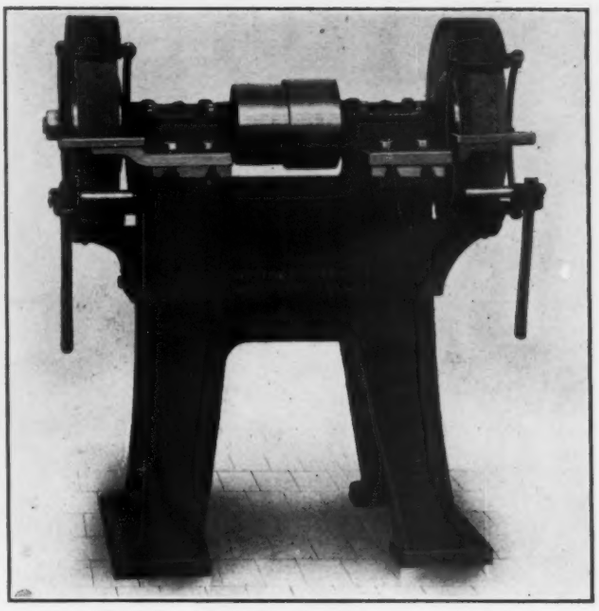

FIG. 2—GRINDING MACHINE EQUIPPED WITH TWO WHEELS PROTECTED BY HOODS

Protection Hoods for Grinding Wheels

Owing to the high speeds at which grinding wheels are operated, their use is always attended with a certain element of danger to the operator. A satisfactory method of safeguarding these wheels is by the use of protection hoods. In the accompanying illustrations are shown two types of these safety appliances, manufactured by the Norton Co., Worcester, Mass., for use on the various grinding machines manufactured by this concern. In Fig. 1 is shown the enclosed type of hood for use on plain grinding machines and in Fig. 2 is illustrated an open hood consisting of a circular band of steel plate, slightly wider than the wheel it covers. The band is cut out for about one-fourth of its circumference and the two ends are joined together by a steel link. This hood has a considerable elasticity, which, under actual breaking conditions, permits the hood to bend out of shape, tending to straighten out the link.

Repeated tests on wheels which have been speeded up to the bursting point have shown that the broken pieces fall harmlessly to the floor, without injury to the operator or machine. This hood can be adjusted to meet the different requirements of the various sizes of wheels.

A. E. Donville, formerly connected with the Nevius Castings Co., Philadelphia, is now associated with the American Car & Foundry Co., with offices at Detroit.

A Power-Ramming Molding Machine

A new type of power-ramming molding machine has been added to the line of foundry labor-saving equipment built by the J. F. Webb Mfg. & Supply Co., Davenport, Ia. This machine is designed for duplicate work and for the use of loose patterns. Plated patterns also can be employed and when a model is mounted in this way both cope and drag are rammed at the same time. On the other hand, when loose patterns are employed the two halves of the mold are rammed separately. In Fig. 1 the ramming head is swung back preparatory to placing a flask on the molding table. In Fig. 2 a snap flask with a plated

FIG. 1—PNEUMATIC POWER-RAMMING MOLDING MACHINE WITH SQUEEZER HEAD SWUNG BACK

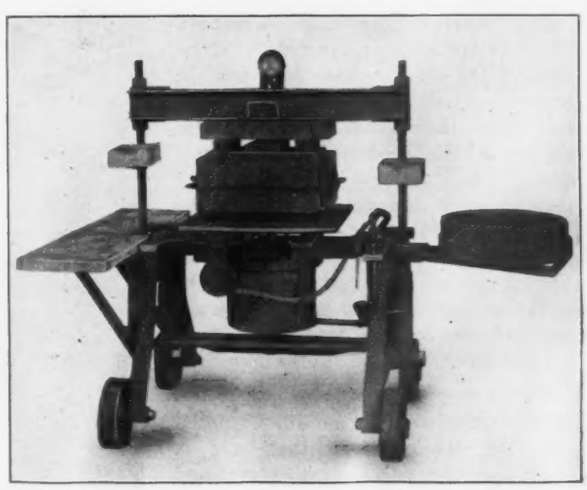

FIG. 2—PNEUMATIC POWER-RAMMING MACHINE IN MOLDING POSITION

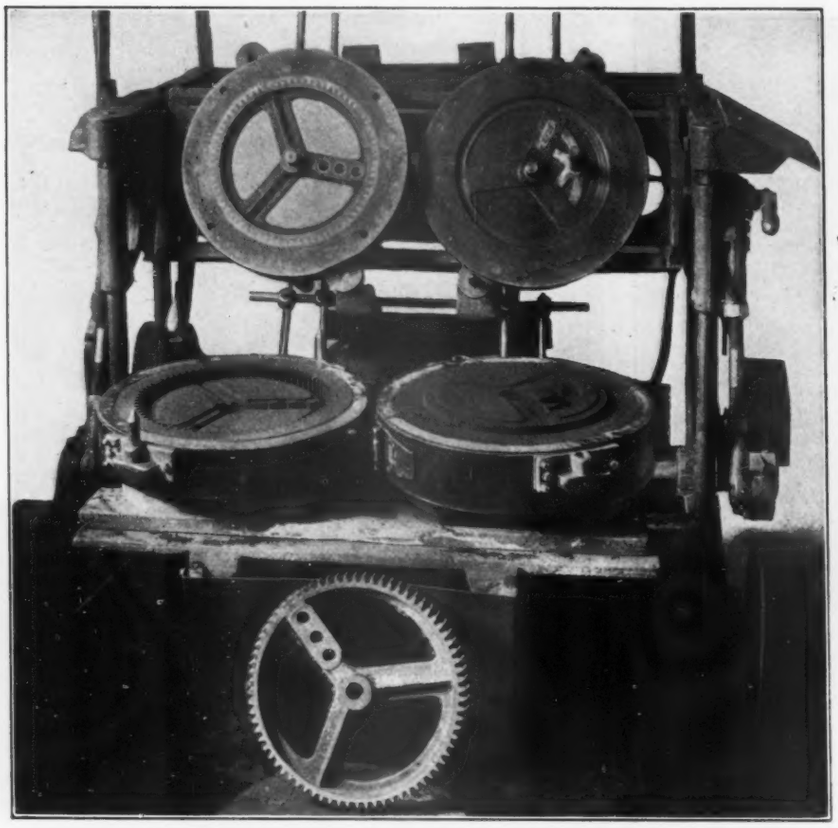

FIG. 1—AUTOMATIC STRIPPING PLATE FOR USE ON THE MODERN MOLDING MACHINE

pattern is shown in position and the head is swung forward in position for ramming the mold. Two styles of vibrators can be utilized, either attached to the machine or to the pattern plate. The ramming of the mold is accomplished by compressed air which is admitted to the cylinder underneath the molding table.

New Stripping-Plate Device

The Arcade Mfg. Co., Freeport, Ill., has recently perfected a stripping plate mechanism for use in connection with its Modern molding machines, the details of which are shown in the accompanying illustrations. The pattern is drawn up through the stripping plate instead of down and this constitutes the principal feature of the apparatus. The mold shown in the illustrations is for a 12-inch pump-jack gear casting and one of the finished castings is displayed in the foreground in Fig. 1.

Referring to Fig. 1 it will be noted that the drag half of the mold is made with the stripping plate and the cope half with a plain pattern plate, the gate being in the cope. In making the mold, the two halves of the flask are first placed in position, filled with sand and clamped; then the table is rolled over and the mold squeezed exactly as in handling an ordinary job. The patterns are also drawn in the usual way by lifting the operating lever of the machine. During this operation the stripping ring rests on the top of the mold and the pattern strips out through it, the ring following when the pattern is completely drawn. The table with the pattern is finally returned to its first position, shown in Fig. 2, and the stripping ring drops back into place ready for another mold. The finished mold is shown at the left in Fig. 2 and the circular snap flask used in making it is at the right.

There is practically no wear on the stripping plate since the sand drops away from it. The drag does not have to be rolled over, being below the pattern when the latter is drawn and the three hanging cores shown in the drag in Fig. 1 do not have to be nailed. The operation of the stripping plate is entirely automatic and the molding machine is handled in the usual way.

Core Oven Installations

The J. D. Smith Foundry Supply Co., Cleveland, is installing a large battery of core ovens in the plant of the Interstate Foundry Co., of that city. In addition, an installation of a battery of core ovens is being made at the plant of the Lycoming Foundry & Machine Co., Williamsport, Pa., and a trolley system is being added to the equipment of the plant of the American Car & Ship Hardware Mfg. Co., New Castle, Pa.

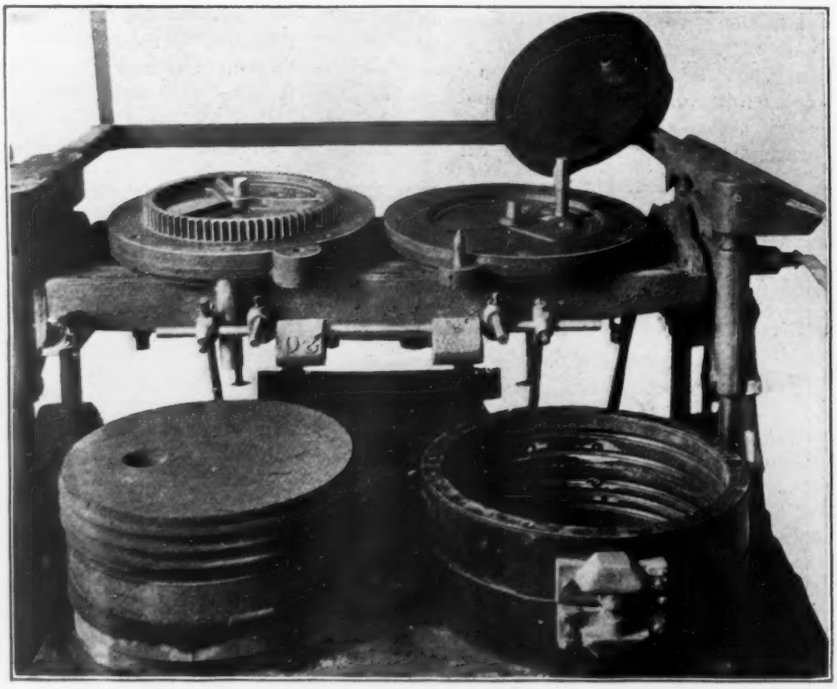

FIG. 2—STRIPPING PLATE AND GEAR PATTERN, TOGETHER WITH GEAR MOLD

Publications of Interest to the Foundry Trade

TURBINES.—A folder issued by the Kerr Turbine Co., Wellsville, N. Y., is devoted to the line of turbines built by this concern. Illustrations of installations are included, interesting steam consumption curves are given and size comparisons are made.

INDUSTRIAL RAILWAYS.—In an 80-page catalog, issued by the C. W. Hunt Co., New York City, industrial narrow gage railways for handling raw and finished material in foundries, iron and steel mills, power plants, etc., are illustrated and described.

AIR COMPRESSORS.—In a 24-page booklet, the Pennsylvania Pneumatic Co., Erie, Pa., illustrates and describes the Barr, unit-compound air compressor. Various types of machines are shown including the single steam-driven, single belt-driven, twin belt-driven and single motor-driven.

CHAPLETS.—A 12-page folder, issued by W. W. Lindsay & Co., Harrison building, Philadelphia, contains illustrations and a price list of the various types and styles of chaplets manufactured by this company. These include radiator, perforated, ventilated, ferrule, rivet stem stove, double head, water back and motor chaplets, as well as single head, upset head and hook anchors and forged anchor stems. An extensive line of stove specialties also is included.

TRUCKS AND CARS.—In a well arranged and well-illustrated, 160-page catalog, the Chase Foundry & Mfg. Co., Columbus, O., describes its extensive line of trucks and cars, switches, turntables, steel ties, portable track and all kinds of industrial railway equipment. The cars and trucks shown are designed for use in all kinds of manufacturing plants, including foundries, rolling mills, machine shops, etc. Roller bearing core oven cars are made in various styles and sizes, as well as coal and coke charging cars, dumping buckets, etc.

FANS AND BLOWERS.—A number of bulletins have been issued by the American Blower Co., Detroit, devoted to a number of its various products, including Sirocco fans and blowers, cast iron blower and exhaust fans, vertical self-oiling engines, twin variable speed steam engines, steam traps and ventilating sets. The bulletins briefly illustrate and describe the different machines and equipment and views of numerous installations and testimonial letters from satisfied users are included.

FLASKS, WHEELBARROWS, ETC.—In catalog No. 16, issued by the Sterling Wheelbarrow Co., West Allis, Wis., its extensive line of rolled steel flasks, steel wheelbarrows, etc., is illustrated and described. Many views are included, showing foundries equipped with rolled steel flasks and various types of flasks, shop boxes, etc., are included. An extensive line of wheelbarrows, foundry and pig iron trucks also are illustrated. The catalog includes price lists and the names of users of rolled steel flasks.

TROPENAS CONVERTERS.—"Tropenas Converters at Panama" is the title of an interesting booklet issued by the Tropenas Converter Co., New York City, which briefly contains a history of the Panama canal, an outline of how it is being built, together with a resume of the cost of making steel castings in the canal zone by the Panama canal commission. In the gray iron foundry operated at Gorgona, a Tropenas converter has been installed which will permit the government to make steel castings for necessary canal repairs and replacements.

PNEUMATIC DRILLS.—In a 16-page bulletin, the Ingersoll-Rand Co., 11 Broadway, New York, illustrates and describes "Little David" pneumatic drills, which are adapted for all the ordinary work of a pneumatic drill such as reaming, tapping, drilling, flue rolling and wood boring. The motor or engine is of the angular, four-cylinder, single-acting, reciprocating type, each pair of pistons being attached to opposite throws of a double crank shaft. The machines are built reversible but can be made non-reversible. The valve action is such that there is no compression of exhaust.

MOLDING MACHINES.—The Osborn Mfg. Co., Cleveland, has issued a handsome loose leaf catalog devoted to its extensive line of molding machines. These include the following types: Power and hand-ramming, direct-draw, rock-over, roll-over rock-down, adjustable flask-stripping, drop-plate squeezer, as well as special machines for making cores. The illustrations, to a large extent, show practical shop operations and the construction of these machines is described in detail. A pattern-drawing device and a core sand washing machine are shown, in addition to foundry accessories, including snap flasks, flask trimmings, vibrators, etc.

FLEXIBLE SHAFTS.—An 88-page catalog, issued by the Stow Mfg. Co., Binghamton, N. Y., is devoted to the line of products manufactured by this concern. The Stow flexible shaft, adapted for all purposes such as the operation of portable drills, grinders, etc., is illustrated and described, together with universal joints for use in connection with this shaft. Scratch brushes for use in connection with portable grinders are shown. This company also manufactures multi-speed motors of the open and semi-enclosed types and various applications of these machines are illustrated. The catalog is well-arranged and many of the large number of the applications of flexible shafts are illustrated.

FOUNDRY SUPPLIES AND EQUIPMENT.—A pocket edition of the foundry supply and equipment catalog and price list of the S. Obermayer Co., Chicago, recently has been issued and should prove exceedingly convenient to foundrymen generally, who desire to carry a copy of this reference work with them while in the shop. The catalog contains 321 pages and a well-arranged index adds to its attractiveness. The entire line of supplies required in gray iron, steel, malleable and brass foundry operations is illustrated and described, together with the necessary equipment for these shops. A price list also is included, together with a large number of tables and handy information for foundrymen.

VANADIUM STEELS.—The American Vanadium Co., Pittsburgh, in an 80-page catalog, gives comprehensive directions for the application of vanadium to iron and steel and the classifications and heat treatment of vanadium steels are extensively covered. Various types of vanadium steel are considered at length with interesting data covering their physical properties and chemical constituents. The addition of vanadium steel in acid and basic open-hearth, crucible, Bessemer, Tropenas and electric furnace practice, is described in detail and directions are given for its addition to cast iron. This work can be considered a text-book on vanadium and should prove of value to metallurgists, steel works' operators and foundrymen.

TAPPET DRILLS.—A 16-page bulletin issued by the Ingersoll-Rand Co., 11 Broadway, New York, is devoted to a description of their line of arc valve tappet rock drills. This drill is an evolution of the earlier tappet drills, and has many improvements over the pioneer type of drill. One of its important features is an arc shaped valve, which is moved on a circular seat by a rocking tappet. The working pressure is exerted on the back of the valve, which forces it back to its seat with a positive action that obviates all danger of leakage from wear. The mode of operation of the drills under varying conditions, in mines and open workings is illustrated, and the various parts required for repairs are listed in a table, and are identified by views.

STEEL CASTINGS.—"Steel Castings That Are Steel" is the title of a 12-page booklet issued by the Treadwell Engineering Co., Easton, Pa., and compiled by W. E. Farrell. Considerable space is given to a forge test made for the purpose of distinguishing between cast iron and steel or wrought iron and in addition explains the quality of castings offered as steel. Test pieces were purchased from 18 foundries advertising as manufacturers of steel castings and after making analyses a casting from each lot was heated to a forging temperature in an ordinary blacksmith's fire. Without reheating, the test castings were flattened under a steam hammer. Illustrations are included, showing the flattened test pieces with directions for distinguishing between cast steel and other metals.

COLD SAW CUTTING-OFF MACHINES.—The extensive line of cold saw cutting-off machines built by the Newton Machine Tool Works, Philadelphia, is described in a well-arranged and well-illustrated 112-page catalog, recently issued. The entire subject of cutting metal cold is discussed at length and a brief historical sketch is included covering the development of cutting-off machines. Before the Newton company built its first machine only six of these tools were in use in this country and were of English manufacture. The first Newton machine was built in 1889 for the Midvale Steel Co. and the second machine, shipped shortly after the Midvale order, is still in operation in Philadelphia. These metal sawing machines are essentially milling machines operating a slitting cutter of large diameter and all the usual practice in the operation of milling machines, it is stated, should be observed in the operation of cold saws. For material high in carbon and manganese, or unannealed stock, the speed should be low and the feed should be increased. This applies particularly to cutting off gates or risers on steel castings. Suggestions are included with reference to the cutting compound to be used and the care of saw blades also is outlined. The many different types of machines built are illustrated and described in detail and these include machines for cutting steel bars, I-beams, girder rails, internal cold saw cutting-off machines, combination machines, milling machines, portable slotting machines, rotary planing machines, gear cutting machines, crank shaft cold saw cutting-off machines, as well as an extensive line of machines for use in steel foundries for cutting off gates, risers, etc.

General Industrial Notes

The Barry Mfg. Co., Muscatine, Ia., is completing the erection of a foundry 60 x 160 feet, of steel and concrete construction.

The Garden City Foundry Co., Chicago, has been incorporated with a capital of $10,000 to operate a foundry and machine shop. The incorporators are J. M. Dresser and H. M. Fernbac.

The Melvin-Lloyd Co., Youngstown, O., has been incorporated with a capital of $10,000 to operate a foundry, machine and pattern shops. The incorporators are Chas. P. Melvin, Geo. P. Lloyd and David Richards.

The Ashland Foundry Co., Ashland, O., has been incorporated with a capital of $15,000. The incorporators are Maurice V. Sample, Robt. McIntosh, Ralph Helbert, Edward P. Helbert and A. W. Fritzinger.

The Blake Car Step Works, Charlotte, N. C., has commenced work on the erection of its new plant, which will include a foundry, machine shop and pattern department. The Piedmont Brass Works is affiliated with this company.

John R. Forbes, Jersey City, N. J., who was forced to abandon his old foundry as the site was required for municipal purposes, has commenced operations in his new foundry, which is 45 x 100 feet, located near Grand and Golden streets.

The Romeo Foundry Co. has leased the old malleable iron works known as plant No. 3 of the Port Huron Engine & Thresher Co. at Port Huron, Mich., which will be equipped for casting motor cylinders and piston rings exclusively for the Ford Motor Car Co., Detroit.

The Valley Machine Co., Parkersburg, W. Va., has been incorporated with a capital of $150,000 to operate a foundry and machine shop. The incorporators are B. B. Putnam, Marietta, O.; James Turpin, Dayton, O., and Ferguson O'Connor, R. G. Stiles and John Marshall, Parkersburg.

The Dominion Steel Casting Co. Ltd., Hamilton, Ont., expects to commence operations in its new foundry about Sept. 15. This company is installing a 2-ton oil-fired converter and has acquired the rights for the use of this converter system for the province of Ontario.

The Allyne-Ryan Foundry Co., Cleveland, O., recently incorporated with a capital of $100,000, will shortly erect a new plant, including a foundry, 80 x 100 feet, core room, 100 x 160 feet, and a two-story building for office purposes. The company will make a specialty of automobile castings. D. J. Ryan, superintendent of the Interstate Foundry Co., Cleveland, is president and manager. E. E. Allyne, president of the Allyne Brass Foundry Co., and the Aluminum Castings Co., Cleveland, also is interested in the new company.

The Columbus Machine & Tool Co., incorporated recently with a capital of $500,000, has purchased the plants of the Columbus Machine Co., Columbus, and the Vulcan Foundry Co., Warren, O. Contracts have been placed for the erection of a new plant at Columbus for the manufacture of gas, gasoline and oil engines up to 600-horsepower capacity, mechanical stokers, shaking grates, bolt-making machines, etc. Until the completion of the new plant the product is being manufactured in the works of the Columbus Machine Co. D. H. Palmer is president. Orders for machine tools and power plant equipment have not yet been awarded.

At a recent meeting of the board of directors of the Continental Radiator & Foundry Co., St. Louis, the following officers were elected: L. F. Ostrander, president; T. C. Skeen, vice president; Benj. C. Crosby, treasurer, and John J. Ostrander, secretary. The capital stock was increased to $300,000, of which $200,000 is common and $100,000 7 per cent cumulative preferred. In addition to the manufacturing facilities which the company has had heretofore at St. Louis and Belleville, Ill., a large and modernly-equipped plant at Fort Madison, Ia., has been acquired which covers approximately 6 acres. The plant is equipped with two large cupolas. In addition to heating boilers, approximately 8,000,000 feet of radiation will be cast at this shop.

New Construction

The Swartz Foundry Co., Detroit, will erect a new shop of brick construction.

The Western Foundry & Machine Co., Edmonton, Can., will erect a machine shop and foundry at a cost of $60,000.

The Georgetown Foundry Co., Georgetown, Ont., will shortly commence work on the erection of a large iron foundry.

The foundry of the Belcher & Taylor Agricultural Tool Co., Chicopee Falls, Mass., destroyed by fire Aug. 10, will be rebuilt.

The Eby Foundry Co. is erecting a foundry at North Battleford, Sask., which will be placed in operation in about two months.

The Sherbrooke Iron Works, Sherbrooke, Que., will erect new buildings, including a foundry, boiler and machine shops.

M. W. Kellogg, Jersey City, N. J., has commenced work on the construction of a 70 x 105-foot extension to his gray iron foundry.

The Athol Machine Co., Athol, Mass., iron founder, will erect a new three-story building, 60 x 142 feet, of brick and concrete construction.

The Norton Co., Boston, Mass., is planning the erection of a gray iron foundry next year for the manufacture of castings used in its grinding machines.

The Canada Car Co., Lansdowne & Royce avenues, Toronto, is erecting a foundry for the production of ornamental iron castings, at a cost of $110,000.

The Albany Foundry Co. and the Troy Machinery Works Associated, will rebuild their foundry and nickel-plating shop on Van Renssaeler Island, N. Y.

The Columbus Machine & Tool Co., Columbus, O., will erect a new plant which will include a foundry, machine, pattern, blacksmith and erecting and testing shops, etc.

The Davenport Machine & Foundry Co., Davenport, Ia., is having plans prepared for a new foundry, the main building of which will be 75 x 290 feet. New equipment will be required.

The West Steel Casting Co., Cleveland, is enlarging its plant and when the present extensions are completed the capacity will be practically doubled. Castings are made by the converter and crucible steel processes.

The Calhoun Pattern Foundry & Machine Co., Houston, Tex., recently organized, has acquired 270 feet of channel frontage running back 400 feet to the International & Great Northern railroad tracks, upon which it will erect buildings covering the entire site.

The Pioneer Tractor Mfg. Co., Winona, Minn., is erecting a plant at Calgary, Alberta, which will consist of a foundry, 80 x 100 feet, machine shop, 100 x 600 feet, and an office building, 80 x 100 feet. The foundry and machine shop will be of brick and steel construction.

The Bethlehem Steel Co., South Bethlehem, Pa., will enlarge its brass foundry by the erection of an addition 110 x 240 feet. The present round type furnaces will be discarded and square furnaces will be installed. The gray iron pattern shop will be removed to another location to make room for the new addition.

The Hercules Mfg. Co., Centerville, Ia., is erecting a new plant consisting of four building, including a machine shop and erecting room, 50 x 350 feet, woodworking and pattern shop, 50 x 150 feet; foundry, 50 x 150 feet and an office building, 40 x 50 feet. In addition to the gray iron foundry a crucible steel casting plant will be installed.

The Standard Foundry & Mfg. Co., De Kalb, Ill., is preparing to erect an addition to its main building, 50 x 160 feet. This structure will be used as a foundry and will practically double the company's capacity. A three-motor electric crane for handling large castings, molding machines, air compressor, as well as a sand blast and other equipment will be required.

Among the Brass Founders

Clark & Solsbaug, Boston, Mass., are seeking a site at Edmonton, Alberta, Can., on which they will erect a brass foundry.

The American & Manganese Bronze Co. will erect a new foundry at Holmesburg Junction, Pa. The building will be one-story, 50 x 120 feet.

The Wm. A. Hardy Sons Co., Fitchburg, Mass., brass founders, is having plans prepared for a brick addition to be erected to the company's plant on Water street.

The Davis & Furber Machine Co., North Andover, Mass., recently placed in operation its new core-making and brass-melting departments. Melting furnaces and reel type core ovens built by the Rockwell Furnace Co., New York City, have been installed.

The Utica Brass & Machine Co., Fort Worth, Texas, is installing new machinery for the manufacture of brass, bronze, Muntz metal and copper castings. The officers of the company are R. L. Carr, president; J. M. Bird, general manager and vice president and F. L. Lightfoot, secretary.

The United States McAdamite Metal Co. has removed its foundry from Brooklyn, N. Y., to Detroit, where a new plant has been erected at Isabella avenue and the Michigan Central railway. This concern manufactures special alloys and aluminum castings.